Improved Performance Research Integration Tool (IMPRINT)

User's Guide

Version Standard

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Improved Performance Research Integration Tool (IMPRINT) User's Guide

Chapter 1 - Getting Started in IMPRINT

The Improved Performance Research Integration Tool (IMPRINT) was developed for the Army Research Laboratory (ARL) Human Research and Engineering Directorate (HRED). IMPRINT is government-owned and consists of a set of automated aids to assist analysts in conducting human performance analyses. IMPRINT provides the means for estimating manpower, personnel, and training (MPT) requirements and constraints for new weapon systems very early in the acquisition process.

Some of the key features of IMPRINT are:

- Includes extensive MPT data libraries on existing weapon systems
- Estimates operator and maintainer manpower requirements at the system, unit and force levels
- Projects future manpower levels and personnel characteristics
- Provides task-based analyses that predict changes in performance as a function of changes in personnel characteristics
- Predicts performance effects of environmental stressors and sustainment training frequency
- Estimates crew workload
- Contains mission simulation models that aggregate task performance

ARL HRED distributes IMPRINT. The technical point of contact is Mr. John Lockett (410) 278-5875 (jlockett@arl.army.mil).

Organization of this Document

This User's Guide is organized into seven chapters. In the first chapter, we describe some basic concepts related to IMPRINT. It describes the requirements of the computer system that you need, and describes some basic techniques that apply to the IMPRINT product. In the second chapter, we describe how to install IMPRINT. IMPRINT is available on CD. In Chapter 3, we describe the capabilities of IMPRINT. This chapter is organized hierarchically in the order of the IMPRINT menu items. This organization causes some repetition, in that capabilities that are provided under more than one menu item are discussed in both relevant places. Chapter 4 includes a technical description of how the Operations models execute in IMPRINT. The fifth chapter includes a technical description of the maintenance manpower model that is embedded in the IMPRINT tool. Chapter 6 describes IMPRINT errors that you might see and how you can respond. Finally, the seventh chapter provides a glossary of terms. At the end of this document, we have provided a section for references as well as an index. We have also included an appendix that includes a technical paper discussing the implementation of stressor data in the human performance modeling capabilities of IMPRINT.

An IMPRINT Analysis Guide is available that has a detailed discussion of the types of analyses that you can perform with IMPRINT, and the steps you go through to accomplish each type of analysis. If you are new to the IMPRINT product, we recommend that you review that document.

A significant portion of the functionality available in IMPRINT was provided in a DOS-based tool set called Hardware vs. Manpower (HARDMAN) III. HARDMAN III was a major development effort of the Army Research Institute's (ARI) System Research Laboratory (which has now become part of ARL HRED). More information on the capabilities of the original HARDMAN III tools can be found in the HARDMAN III Final Report (Adkins and Dahl, 1993).

Basic IMPRINT Information

There are several things about IMPRINT that it is useful for you to know before you begin using the application.

The minimum amount of **RAM** needed to run IMPRINT is 64MB.

To generate, view and print **reports** in Imprint, you must have at least one printer driver installed on your machine. You must also have Microsoft Excel version 5.0 or later installed on your machine.

Dialog boxes, similar to the one shown in Figure 1-1, are used throughout the application. Almost all the dialog boxes will have three common buttons.

The "**OK**" button, when clicked, accepts any input you entered within the dialog box and then closes it. **It is important to understand that the actions taken in the dialog box are put into temporary storage and not yet written to permanent storage on the hard disk.** In order to save the actions to permanent storage, you must use the main menu "File" - "Save" options (similar to saving a document in Word for Windows). **We recommend that you save your work frequently when conducting analyses with IMPRINT.**

The "**Cancel**" button, when clicked, discards any data you entered within the dialog box and then closes it.

The "**Help**" button, when clicked, provides context sensitive help for that particular dialog box.

To enter any **time** data, use the mouse to position the cursor in the time standard box. The format for all time values is **hh:mm:ss.00**. So to enter a time standard of 30 minutes, 15 seconds enter 00:30:15.00. Notice that you can enter hundredths of a second after the decimal point.

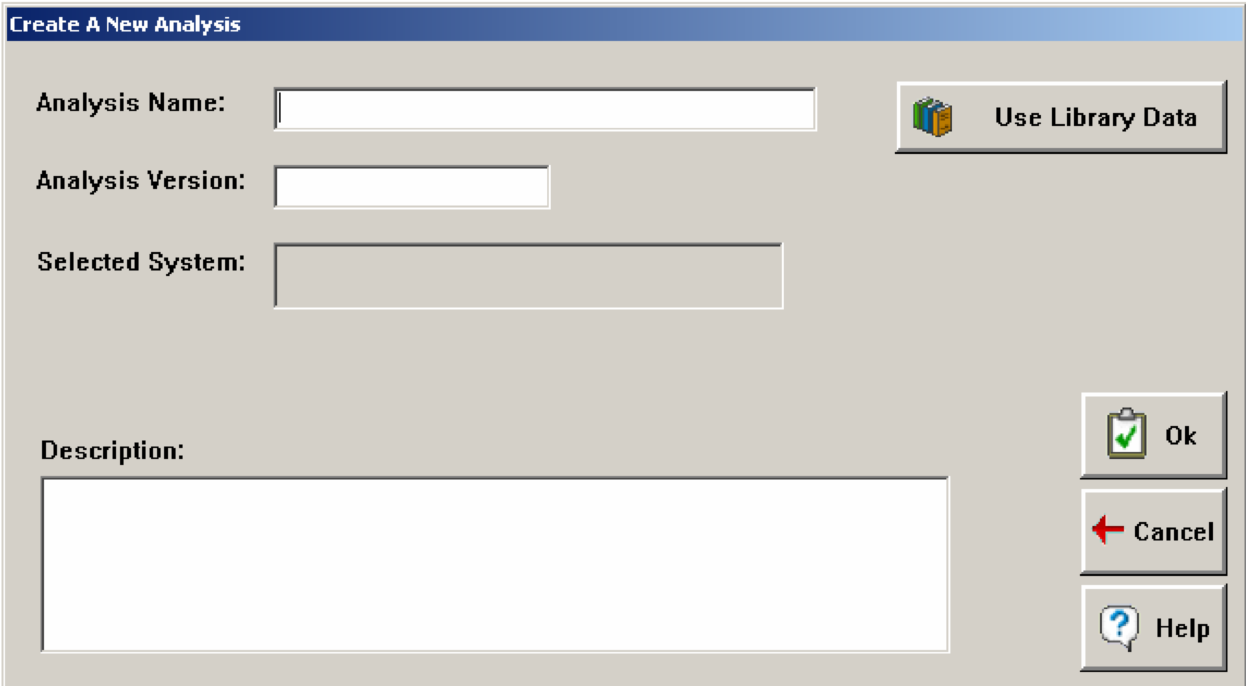


Figure 1-1. Example IMPRINT Dialog Window

Basic Windows Information

As you work with IMPRINT, you will be accessing, entering, and manipulating information in the Microsoft Windows environment. IMPRINT is designed to be consistent with Windows user interface standards. If you are not familiar with other Windows applications, we have provided a brief description of the basic elements of IMPRINT windows.

Most of the windows in IMPRINT will have many elements in common. However, not every window has every element. For detailed information about all aspects of the Windows environment, refer to your Microsoft Windows User's Guide.

Version 7 of IMPRINT does not display windows on top of another. There is only one dialog open at a one time. Figure 1-2 shows the general window layout.

Control Menu Box - The upper right corner of most windows contains the control menu box. When you click this box, the control menu displays. The control menu is most useful if you want to manipulate the window from the keyboard rather than with a mouse. By using the control menu, you can resize, move, maximize, minimize, and close the window. If you use a mouse, you can click and drag to perform these tasks.

Title Bar - Appearing at the top of the window, the title bar shows the name of the application, document, or window. If more than one window is open, as in the illustration above, the title bar for the *active* window (the one in which you are working) is a different color or intensity than other title bars. If you hold down on the mouse button while pointing to the title bar, you can drag the entire window to a different location on the screen.

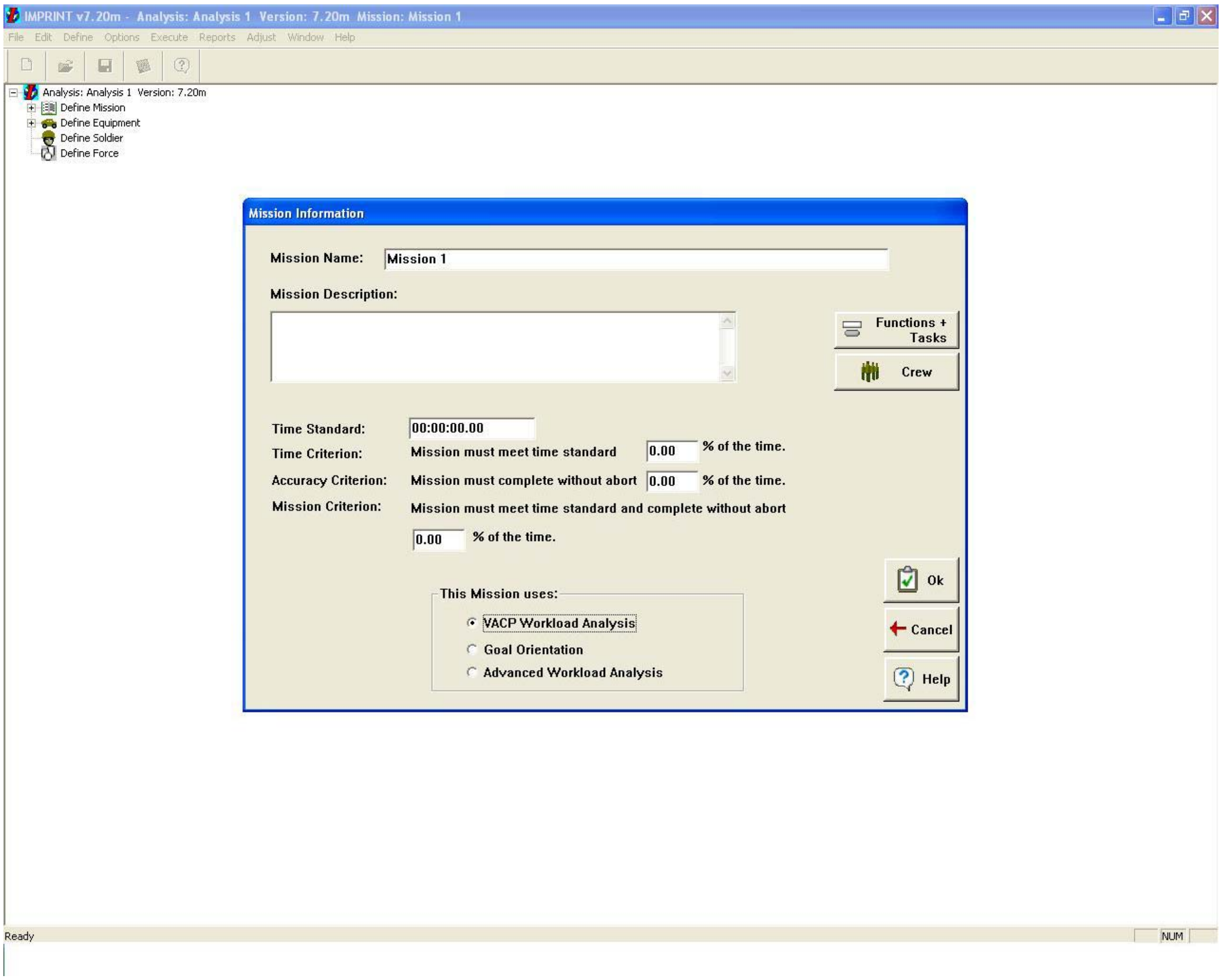


Figure 1-2. General Window Layout

Menu Bar - This bar shows the available menus. A menu contains a list of commands, actions, or options you can carry out in IMPRINT. The File menu, Edit menu, and Help menu are common to many Windows applications. The Define, Options, Execute and Adjust menus are unique to IMPRINT.

Scroll Bars - The bars help you scroll either horizontally or vertically through the contents of a document to display information that will not fit in the window. You can use scroll bars to view unseen portions of lists and other information that cannot fit in the allotted space of the window.

Maximize Button - When you click this button, you will enlarge the active window so that it fills the entire desktop workspace.

Minimize Button - Lets you reduce the window size to an icon.

Restore Button - After you enlarge a window to its maximum size, the Restore button that contains both an up and a down arrow replaces the Maximize button. You can click the Restore button to return the window to its previous size. From the keyboard, you can select the Restore option on the Control menu to perform the identical function.

Command Buttons - You choose a command button to initiate an immediate action, such as carrying out or canceling a command. The OK and Cancel buttons are common command buttons. They are often located along the lower right side of a dialog box window.

Window Border - This is the outside edge of the window. You can lengthen or shorten the border on each side of the window by pointing to it with the mouse cursor and holding the mouse button down while you drag the mouse in the desired direction.

Window Corner - Use this to lengthen or shorten the two adjoining sides of a window border at the same time.

Mouse Cursor - Appears if you have the mouse installed. When you move the mouse, the position of the pointer changes on the screen. The shape of the cursor itself depends on the location of the cursor on the window. For example, when the cursor is on the menu bar, it looks like an arrow. When the cursor is in a typing field, it looks like an "I." This is the text insertion point.

Navigational Tree

Once you have an analysis open in IMPRINT the Navigational Tree will be displayed in the main IMPRINT window. The analysis name and version are displayed along with the four main sections of IMPRINT: Define Mission, Define Equipment, Define Soldier, and Define Force. The Navigational Tree allows you to navigate through the different sections of IMPRINT without using menus by simply clicking on the icon or text displayed. The user can also quickly drill down through IMPRINT dialogs using the Navigational Tree. On the next page you will find an expanded view of the IMPRINT Navigational Tree.

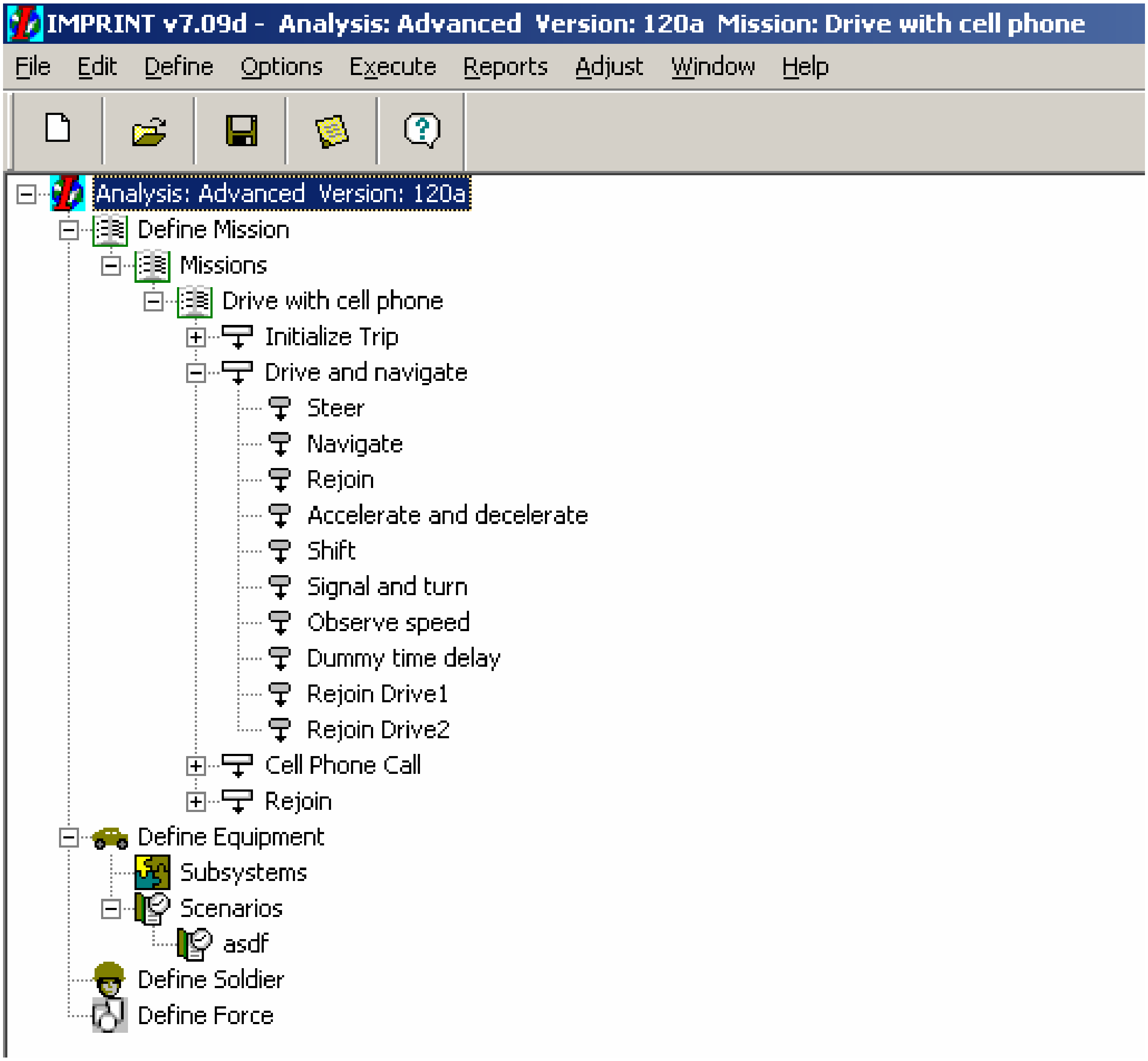


Figure 1-3. Navigational Tree

Chapter 2 - Installing IMPRINT

You will receive IMPRINT on a CD. You can install IMPRINT onto any drive of your PC. This does include LAN drives. If your PC already has a version of IMPRINT installed, and you want to continue to have access to the analyses you have developed with that previous version, we recommend that, as a backup, you export each analysis you want to keep and store them for safe-keeping prior to installing IMPRINT Version STD. IMPRINT STD will, however, automatically convert any IMPRINT 5.0 or 6.0 analyses you have when you run Version STD for the first time. To reduce the time this conversion takes, you can delete any analyses out of your current version of IMPRINT that you no longer need.

If you want to have access to two different versions of IMPRINT at the same time, please contact technical support for guidance.

Follow these steps to install IMPRINT Version STD:

1. Download mysql 3.23.58 from www.mysql.com.

2. Install mysql 3.23.58 by double clicking on the setup.exe.

3. Place the IMPRINT CD in the appropriate drive of your PC.

4. From the Start Menu in Windows 95/98, NT, 2000, or Windows XP, select the "Run…" command

5. At the prompt on the "Run" menu, enter the drive letter where you have put the IMPRINT disk, and type "Setup." As an example, if you have put an IMPRINT CD in the D drive of your machine, you would type D:\Setup.

6. The installation program will display the IMPRINT logo and will take a few seconds to initiate. Click on the "OK" button if you want to continue installing IMPRINT. Click on the "Cancel" button to halt installation.

7. On the next screen, IMPRINT will ask you to identify the directory into which you want to install the software. It will default to C:\imprint7. It is highly recommended that you install to this directory. You can use the "Browse" button on this screen to search through your directory structure and find the directory you want. You can also type in a directory name that does not exist. IMPRINT will create that directory for you. Then, click on the "Next" button to continue installing IMPRINT.

8. After the installation is complete, you should reboot your computer before attempting to use IMPRINT.

Note: to install Imprint through a Windows Explorer window instead of through a DOS prompt, follow steps 1-3. Then, navigate to the contents of the CD, and double-click the "Setup.exe" file. This will start the installation wizard. Proceed with steps 6-8.

Chapter 3 - Using IMPRINT

Introduction

This chapter provides a detailed description of the menu items available in IMPRINT. It is organized in the same order as the IMPRINT menu items themselves, proceeding from left to right, top to bottom, beginning with the items on the "File" menu, and concluding with the items on the "Help" menu.

If you have questions regarding the capabilities of IMPRINT and how you would use it to answer your specific questions about your system, we recommend that you refer to the IMPRINT Analysis Guide. This document is available from ARL HRED or is available as a Word file in the Documentation folder within the IMPRINT folder you created during a full installation.

File Menu

New

You use this menu option to begin working on a new analysis.

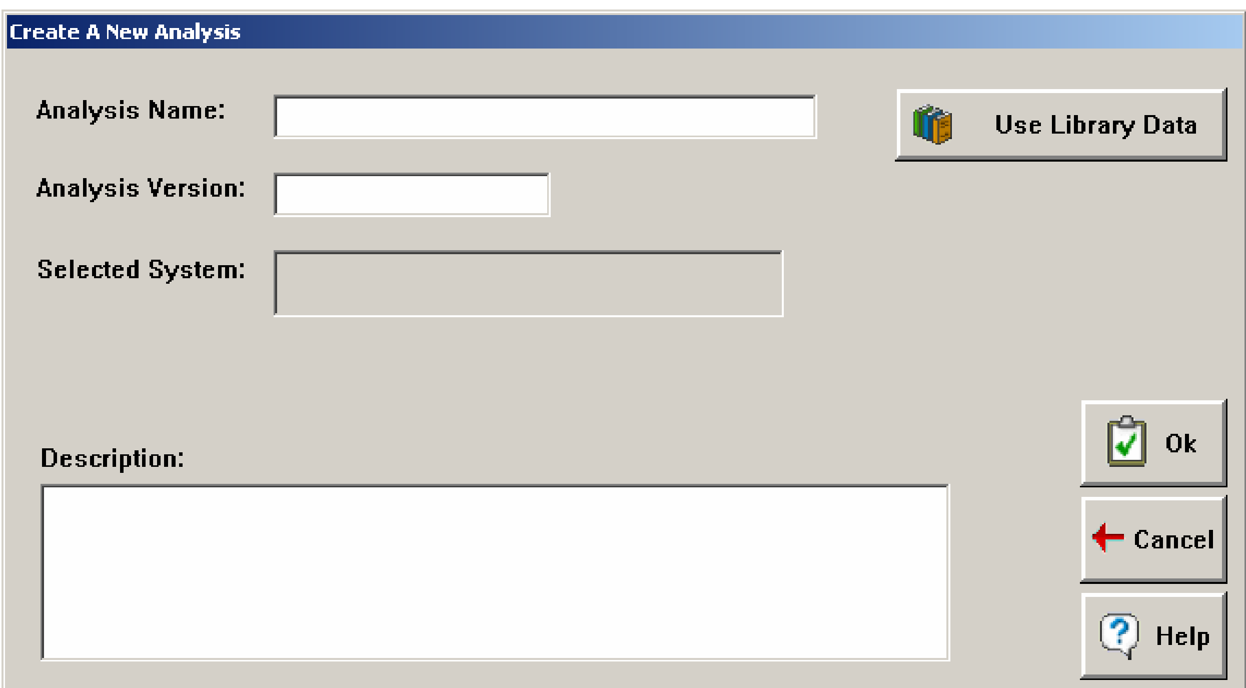


Figure 3-1. Create A New Analysis

From the main menu option "File" choose "New" or click on the "New" icon on the tool bar. This will display a dialog box, shown in Figure 3-1, which is used to name your new analysis. You must enter both an "Analysis Name" and an "Analysis Version." Those two names uniquely identify your analysis. Optionally, you can also enter a textual description of your analysis so that you will have a reminder of what the analysis is about when you recall it later.

Use Library Data Button

IMPRINT contains libraries of data on numerous currently fielded Army systems. The purpose of these data is to provide you with a starting point for conducting your analyses. For example, if you want to conduct an analysis in support of a new tank, you could load the mission models for the M1 tank for reference, and then modify these existing missions to reflect the missions of your new tank.

Once you have entered the required items (Analysis Name and Analysis Version) and any optional ones (Description, Use Library Data) click “OK”. The analysis will now be opened and the name will appear in the title bar of the IMPRINT window.

To use the library data, click on the "Use Library Data" button that is on the "Create New Analysis" dialog. When this button is pressed, a list of all the weapon systems for which IMPRINT contains data will be displayed. You can select the system that is closest to your new system and then press the "OK" button. This will cause the library data for the selected system to be copied into your analysis database. The mission, soldier, and equipment data associated with that library system will be available for you in subsequent dialogs.

The library systems available in IMPRINT include:

Mission Area	System Type	System Name
Air Defense	Air Defense Mobile Gun	M163VULC
Air Defense	HIMAD	Patriot FP
Air Defense	Man-portable Air Defense System	STINGER
Aviation	Attack Helicopter	AH-64A
Aviation	Cargo Helicopter	CH 47D
Aviation	Scout Helicopter	OH 58D
Aviation	Utility Helicopter	UH-60A
Close Combat Heavy	Cavalry Fighting Vehicle	M3 BRADLEY
Close Combat Heavy	Tank	M1 ABRAMS
Close Combat Light	Anti-Tank Vehicle	M901 ITV
Close Combat Light	Automatic Weapon	M249 SAW
Close Combat Light	Grenade Launcher	M203
Close Combat Light	Infantry Fighting Vehicle	M2 Bradley
Close Combat Light	Man-portable Anti-Tank Weapon	DRAGON

Close Combat Light	Man-portable Indirect Fire Weapon	M252 81MM
Close Combat Light	Rifle	M16A1
Combat Service Support	Heavy Truck	M977 HEMTT
Combat Service Support	Light Truck	M998 HMMWV
Fire Support	Medium Range Missile Artillery	LANCE
Fire Support	Rocket Field Artillery System	MLRS
Fire Support	Self-propelled Howitzer	M109A2 HOW
Fire Support	Towed Howitzer	M102 HOW

Open

You should use the “Open” menu item to open an existing analysis.

From the main menu “File” option choose “Open” or click on the “Open” icon on the tool bar. This will give you a list of all the Analysis Names and Versions that are stored in your working files and are available for you to resume work on, as shown in Figure 3-2. In addition, it provides the date you last saved that system and version. When you select a system and version to resume work on, be aware that any changes made will be permanent and old data will be lost. To preserve all your previous work and, at the same time, be able to make changes to that work, you should copy the analysis using the “Save As” option on the main menu item “File” and make the changes on the copy (which will now be saved under a different system or version name).

To select a system and version from the list, highlight it and click the “OK” button. Your analysis will be open after they have completed. The analysis name is then listed in the title bar of the IMPRINT window. Then, IMPRINT is ready for you to select other options.

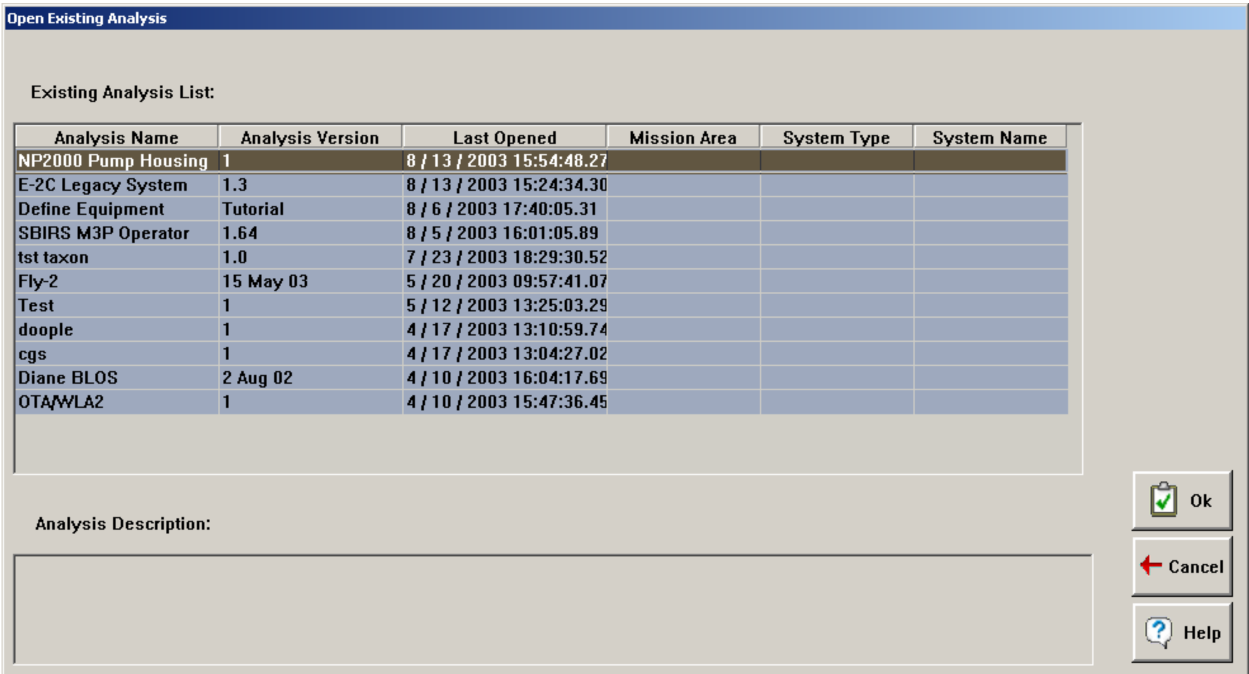


Figure 3-2. Open Existing Analysis

Close

Use this command to close your analysis. You must close an analysis before you can open a new one. This command does not close IMPRINT. If you have not saved all the changes you have made to your analysis when you try to close it, IMPRINT will prompt you so that you can specify whether you want to save or delete the changes you have made.

Save

Use this command to save all the changes you have made to your analysis. We recommend that you save your analysis often.

Save As

Use this command to save your analysis under a new name. When you select this command, you will be prompted to enter a new Analysis Name and Analysis Version.

Delete

Use this command to delete an analysis from your directory and from your list of existing analyses. When you use this command, you will be prompted to identify the analysis that you want to delete. On the “Delete Analysis” dialog, after you have highlighted the Analysis Name and Analysis Version, click on the “Delete” button. You will also be given an opportunity to cancel your selection.

Print Setup

Use this option to set the default printer and change other printer options. You must have a default printer identified in order for the reports to be visible.

Import Analysis

Use this option to import an analysis and all of its data into your list of existing analyses. If that analysis was created in an older version of IMPRINT, then IMPRINT will automatically translate that analysis into a format that is compatible with your version. Note: This command is available only when no analysis is open.

Export Analysis

Use this option to export an analysis and all of its data to another user or for archiving purposes. IMPRINT will save the file wherever you specify. *Be sure that there are no spaces in the path*. The file format is .xch file, so you will not be able to read the export file with a text editor or word processor. Note: This command is available only when no analysis is open.

Import LSA File

You can use this utility to import Logistics Systems Analysis (LSA) Reports into your open analysis. These records include maintenance data, broken out by subsystem and component.

IMPRINT accepts three different LSA formats. These include 750-16, 1388-2A and 1388-2B formats. The first two formats accept the data from the "02" report. The 1388-2B format accepts data from the "01" report. These are standard formats.

Before you import an LSA file, some preparation must be conducted. First, make sure your data are in ASCII text files. Most likely, you will receive your LSA report in a Word document. If this is the case, follow these steps before attempting to import the data:

Open the file in Word.

Select the entire file, and change the font to Times New Roman, and the size to 6 point. This should remove the wrap-around from your data records. You do not need to make any other modifications to the file.

Save the file as a text file, with line breaks. Make sure the extension is *.txt.

Next, open the analysis in IMPRINT into which you want to import the data. If any equipment data exist for that analysis, the new data will be appended to your existing data. Choose "Import LSA File" from the “File” menu in IMPRINT. You will be prompted to identify your LSA file. Browse to the place in your directory structure where you have stored the *.txt file and select the file.

IMPRINT will prompt you to identify the format of the file. Choose the correct format. The most common format is 1388-2B.

Now, IMPRINT will ask you to identify whether you want to filter any of the LSA records. You can specify that records that have a small estimated maintenance man-hour requirement not be imported into your database. This will make your analysis more efficient. The default filter value is .10 annual maintenance man-hours. Any records that are filtered will be stored in a text file in your IMPRINT directory named "filtered.txt." You can review the filtered records at your leisure.

As IMPRINT imports your data, it may ask you questions. For example, it is common for LSA data sets to be of an inconsistent quality. Duplicate records for the same component and repair task are common. If IMPRINT identifies any duplicate records, it will ask you which record you would like to keep. You can tell IMPRINT to keep all duplicates. In that case, it will change the component name (by appending an alphanumeric (e.g., "- A" or "- B")) in order to ensure that all component names are unique. If IMPRINT identifies duplicate records that have different MOS', the records will be kept in your data set.

IMPRINT may also find the MOS's (Military Occupational Specialties) that are in your LSA data but are not recognized by IMPRINT. Sometimes these MOS' are too new for IMPRINT. Sometimes they are used to identify civilians. In any case, if IMPRINT finds a MOS that it does not recognize, you will be prompted to assign it to a MOS from the library. Later, you can go into your data and review your reassigned tasks.

After the import is complete, you will have two new text files in your IMPRINT directory (in addition to filtered.txt, mentioned above). All data records that were successfully imported will be documented in "goodrecs.txt." All duplicated records that you chose to discard will be documented in "duplicat.txt." These files are provided for your records, and are not needed by IMPRINT.

Now, you will be able to review and edit the data that have been imported into IMPRINT. You will find your data under the “Define Equipment” option or under the “Options” menu “Review Task Data” menu item, “Maintenance” selection.

Edit Menu

Duplicate

You should use this command to copy data into your open analysis from any other existing analysis in your list. When you choose this option, you will be prompted to identify the existing analysis from which you wish to copy. You will notice that the analysis you have open will not be available in the list.

Once you have identified the analysis from which you want to copy, you will be able to select any level of data, including mission and equipment data, from the hierarchy of existing data in your database.

Notes

Use this capability, illustrated in Figure 3-3, to document your assumptions about the analysis on which you are working. You can enter up to 1000 characters of text. You can also cut and paste text between the notes and the Windows clipboard. You have one note for your analysis.

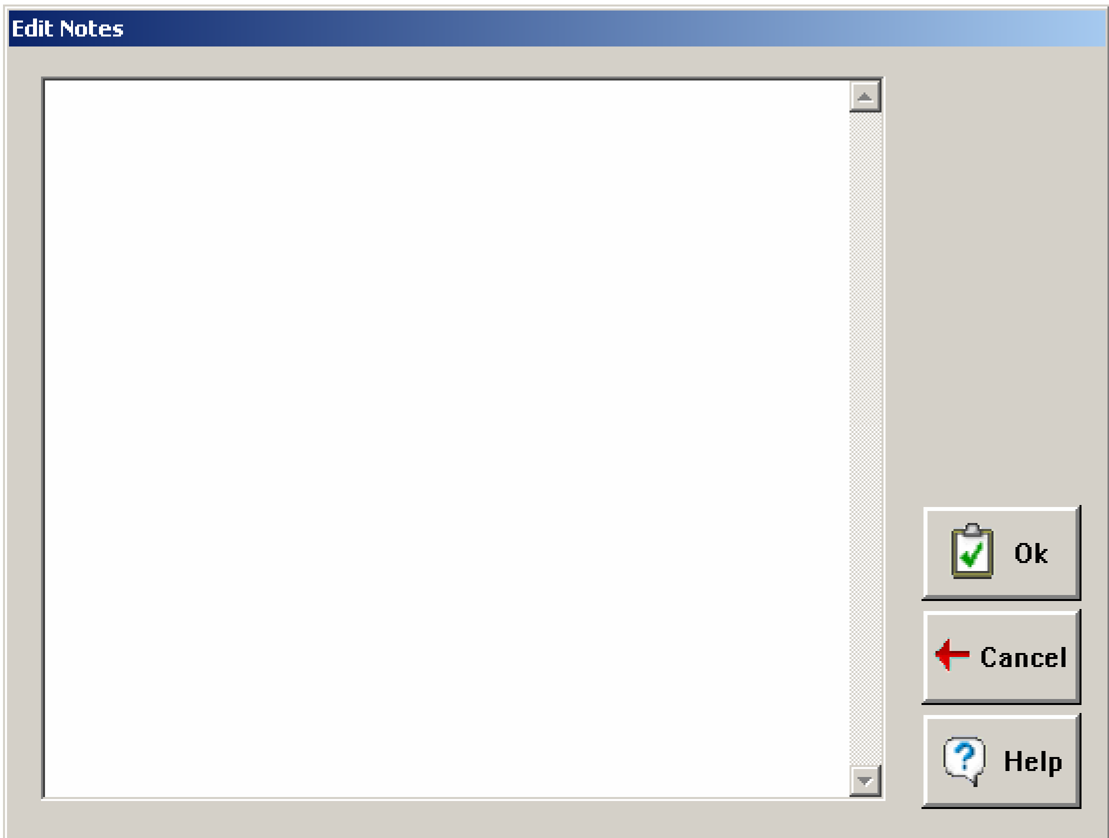


Figure 3-3. Edit Notes

Define Menu

System Mission

IMPRINT allows you to analyze a new weapon system by helping you build models of each mission that the weapon system will be capable of accomplishing. Since it is typically easier to describe the mission by breaking it into smaller "sub" functions than trying to describe the mission as a whole, you build these models by breaking down the mission into a network of functions. Each of the functions is then further broken down into a network consisting of other functions and tasks.

Then, by executing the mission model simulation, you can study the range of results that occur in the mission. A description of the variability of each element can be obtained for further analysis.

IMPRINT performs the simulation analysis based on how long you tell it to perform each task in the mission. In addition, with each task, you estimate accuracy levels and assign workload values that reflect the amount of effort the crewmember will have to expend to perform the task. During the simulation, IMPRINT predicts task performance and calculates how much workload each crewmember was experiencing throughout the mission. In this way, you determine whether the crewmembers were overloaded, and if so, how changes can be made to reduce the workload to an acceptable level.

At the completion of the simulation, IMPRINT can compare the minimum acceptable mission performance time and accuracy to the predicted performance. This will determine whether the mission met its performance requirements.

If you are interested in predicting the workload associated with your mission, you can evaluate workload using the Visual, Auditory, Cognitive, and Psychomotor (VACP) method or the Advanced Workload method. The VACP method is the simpler method and is intended to be used early in your design process. The Advanced Workload method provides a much more detailed look at the workload issue and enables you to examine the impact of workload management strategies. We recommend that you begin by using the VACP method, and if necessary, apply the Advanced Workload method as your analysis matures. When you change a mission from one method to the other, using the radio button at the bottom of the Define Mission dialog, all your data will be preserved and applied to the other analysis. Note: Goal Oriented missions, described in a following section, use the VACP method of workload analysis.

To begin developing a description of the operational system missions, choose the “System Mission...” option from the “Define” menu. When you make this menu selection, IMPRINT will display a list of the missions currently in the working database for the system you selected as shown in Figure 3-4. This list also includes the date you last made changes to each of the missions.

This dialog box includes buttons that enable you to open an existing mission, add new missions to the list, delete the highlighted mission, or make a duplicate of the highlighted mission. To select a mission and open it, highlight it using the mouse, and click on the “Open...” button. Adding, deleting and duplicating can be performed in a similar manner.

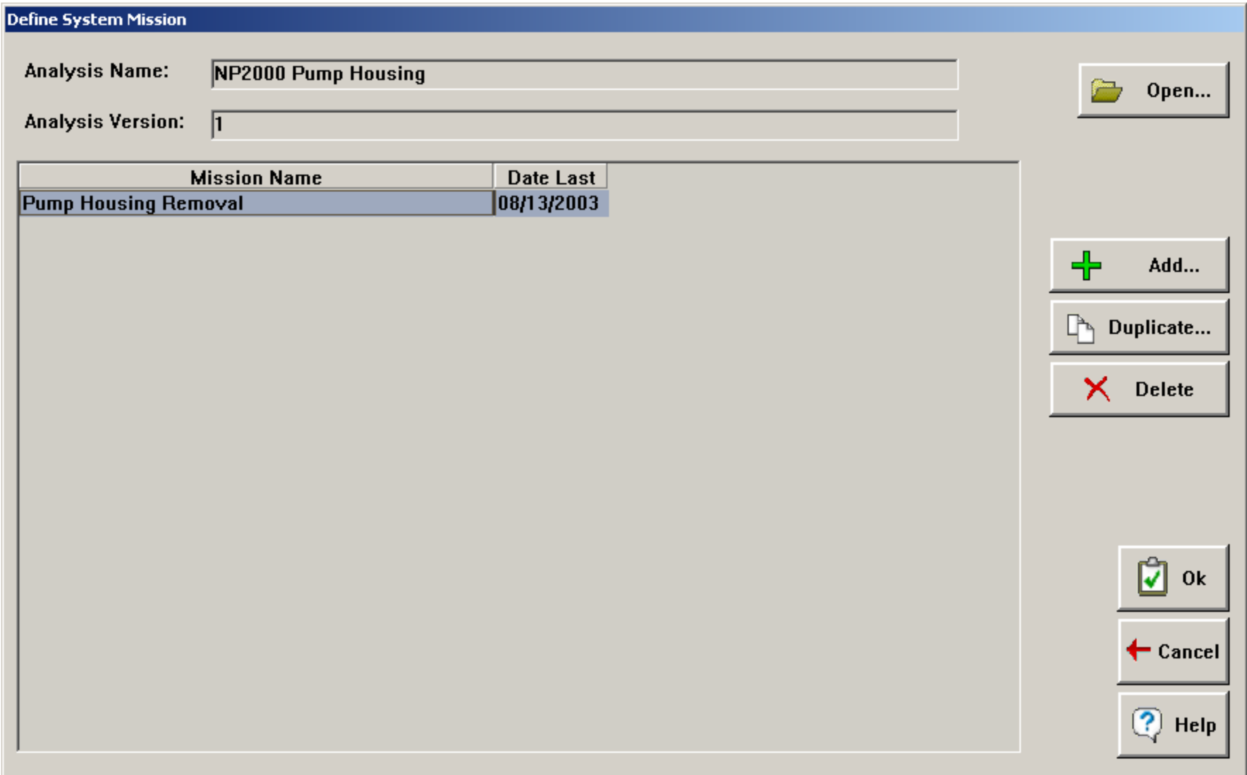


Figure 3-4. Define System Mission

IMPRINT allows you to analyze the performance (i.e., time, accuracy, and workload) of a new weapon system by helping you build models of each mission that the weapon system will be capable of accomplishing.

Duplicate Button

Clicking on the Duplicate button will duplicate the mission (and all its associated data) that is highlighted in the "Mission Name" text box.

Delete Button

Clicking on the Delete button will delete the mission (and all its associated data) that is highlighted in the "Mission Name" text box.

Add Button

Clicking on this button allows you to add a new operational mission to this analysis. If you select this option, be advised that initially the mission will have a name only and no associated data (such as functions and tasks). You can copy functions and tasks from other analyses to the mission by using the "duplicate" option under the "Edit" selection from the main menu.

After you add a mission, you will get the screen shown in Figure 3-5 with only default data filled in. When you open an existing mission, you will get this same screen, with the data you had previously entered.

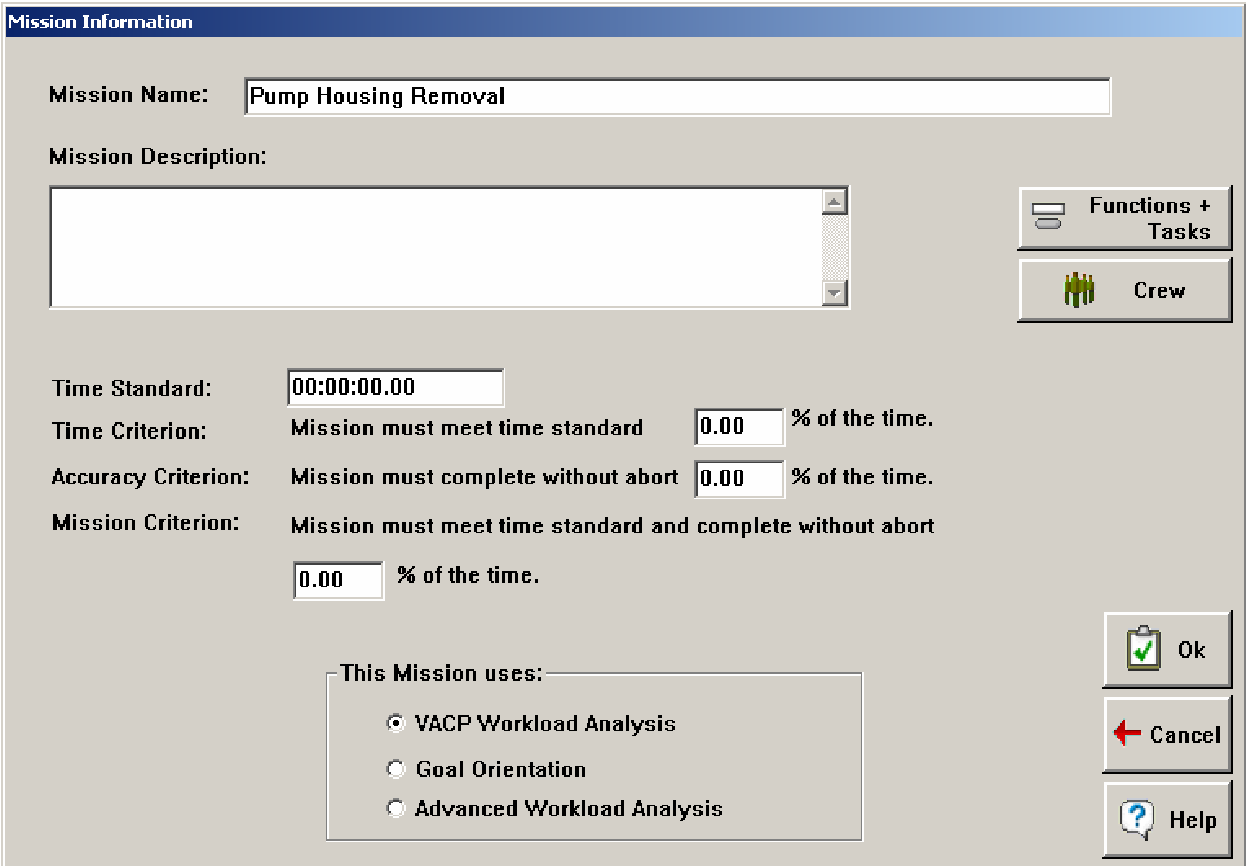


Figure 3-5. Mission Information

The Mission Information dialog box contains several data elements that correspond to the mission that you have selected. At the top of the dialog box is the Mission Name. To change the Mission Name, type over the existing text in the text box. The next data element is the Mission Description, which includes a textual description of the mission. The next data element is the Mission Time Standard. This time standard is the maximum acceptable time by which the mission must be performed in order to be considered a success. The Mission Time Criterion is the percentage of mission runs that must be performed within the mission time standard. Since the elements of the mission are variable, the predicted mission performance will also vary. The criterion allows you to account for this, and gives you an opportunity to specify a realistic percentage of runs that must meet the standards.

The next data element is the Mission Accuracy Criterion. At the task level, an accuracy failure can lead to mission abort. The Mission Accuracy Criterion lets you specify the percentage of time in which the mission must complete without an abort. The final data element is the Mission Criterion. This percentage represents how often the mission must meet both its time and accuracy standards at the same time. Occasionally, your mission may be able to miss either the time or accuracy standard, but here you define how often it must meet both.

Later, you can execute a simulation model of your mission. The results of that mission model will be compared to the standards and criteria you enter here. In the reports, you will receive a summary of how many times the standards and criteria were met.

To change the values in this dialog box, use the mouse to position the cursor in the box you want to change. Click once to set the cursor in the box, and then type in the new value. The format for the time value is hh:mm:ss.00, and the colons are required. Notice that you can enter hundredths of a second after the decimal point.

Functions + Tasks Button

To develop a description of the functions and tasks that make up your mission, choose the “Functions + Tasks” button from the Mission Information dialog box. When you make this selection, IMPRINT will display a list of the functions and tasks currently in the first level of the mission you selected. The name of the Mission you have selected and the Function name are displayed near the top of the dialog box. This list includes an indication of the name of each node and whether each node is a function or a task.

Crew Button

Clicking this button displays a list of the crewmembers for the selected mission. The interface you see varies depending upon whether you are working on an Advanced or VACP mission.

In Advanced Missions, a crewmember or automation device must be assigned to each task in the mission. Each task can be assigned to up to six primary operators. Each primary operator should be equally qualified and able to perform the task. As the task is scheduled to begin, IMPRINT will select the operator with the lowest workload level to perform the task.

You will also be able to assign crewmembers or devices contingency task responsibilities. Each task can have up to one contingency operator designated. Tasks can be reallocated during the simulation only to the designated contingency operator.

Operators that have primary responsibility cannot also be assigned contingency responsibility. Alter the values in the spreadsheet to define the primary and contingency task assignments.

To exit without defining task assignments, click on the "Cancel" button. More information regarding the data needed is provided later in this chapter, under the “Crew” topic.

External Events Button

This button will only appear on the screen if you have chosen either Goal Orientation or Advanced Workload Analysis for your mission analysis method. Clicking this button displays a list of external events for your mission, that occur at specified times. More information regarding the data needed is provided later in this chapter, under the “External Events” topic.

VACP versus Advanced Workload Mission Radio Button

In IMPRINT, you can analyze the workload of operational mission performance in two ways. You can use the VACP (Visual, Auditory, Cognitive, and Psychomotor) method of analyzing workload, or you can use the Advanced Workload capability. Goal Oriented missions provide the VACP method.

The VACP analysis contains a fairly simple version of workload analysis in which workload is estimated by task for each of the four "channels" (i.e., Visual, Auditory, Cognitive, and Psychomotor). As the model runs, workload is summed across tasks, within channels for each operator. At the conclusion of the run, you can see the value of workload versus time and can use this to identify "peaks" during your operational mission. You would then use the outputs of IMPRINT to establish which tasks were being performed during those peaks. These tasks would be candidates for reassignment or redesign.

Goal Oriented missions provide a VACP modeling capability that mirrors the workload analysis capability discussed above. In addition, Goal Oriented missions provide access to some advanced modeling capabilities that you can use to control your missions from externally executing simulations and applications. The techniques you use to connect to other applications are discussed later in this User's Guide.

The Advanced Workload capability contains an implementation of workload modeling according to Chris Wickens' Multiple Resource Theory. This enables you to evaluate crew workload in a very detailed manner. It also enables you to consider the impact of conflicting human resources, and the ways in which crew members will attempt to dynamically manage their workload. This capability was first provided in a tool developed by the Army's Human Engineering Laboratory, named CREWCUT. Later, it was moved to the Microsoft Windows environment, and was named WinCrew. The WinCrew functionality has been embedded in IMPRINT. For more information regarding the theoretical foundation of these products, we recommend that you read the technical documentation produced for the CREWCUT project. For a copy of this documentation, contact Mr. John Lockett at the Army Research Laboratory Human Research and Engineering Directorate (jlockett@arl.army.mil).

IMPRINT enables you to switch missions back and forth between a VACP analysis and an Advanced Workload analysis. You can make this switch by changing the selection on the radio button at the bottom of the Mission Selection dialog. When you switch the setting of the radio button, all your previously entered data will still be accessible and will be applied to the appropriate data items. In this way, you can switch a mission back and forth without losing any data.

NOTE: The remainder of the section of this User's Manual that describes the Define Mission capability is organized by the choice that you make on the mission type radio button (e.g., VACP, Goal Oriented, Advanced). Some of the information is repetitious since many of the interfaces are shared between the mission types. However, this organization allows you to see all of the information in one place for each mission type.

VACP Missions

In IMPRINT, you can analyze the workload of operational mission performance in three ways. You can use the VACP (Visual, Auditory, Cognitive, and Psychomotor) method, the Goal Oriented method, or you can use the Advanced Workload capability.

The VACP analysis contains a simple version of workload analysis in which workload is estimated by task for each of the four "channels" (i.e., Visual, Auditory, Cognitive, and Psychomotor). Then, as the model runs, workload is summed across tasks, within channels for each operator. At the conclusion of the run, you can see the value of workload versus time and can use this to identify "peaks" during your operational mission. You would then use the outputs of IMPRINT to establish which tasks were being performed during those peaks. These tasks would be candidates for reassignment or redesign.

The Goal Oriented capability allows you to model human performance in a goal-driven context. This capability allows you to specify individual goals, the tasks associated with these goals, the triggering conditions, and the interaction of goals. The triggering conditions can be implemented through links to external models.

The Advanced Workload capability contains an implementation of workload modeling according to Chris Wickens' Multiple Resource Theory. This enables you to evaluate crew workload in a very detailed manner. It also enables you to consider the impact of conflicting human resources, and the ways in which crewmembers will attempt to dynamically manage their workload. This capability was first provided in a tool developed by the Army's Human Engineering Laboratory, named CREWCUT. Later, it was moved to the Microsoft Windows environment, and was named WinCrew. The WinCrew functionality has been embedded in IMPRINT. For more information regarding the theoretical foundation of these products, we recommend that you read the technical documentation produced for the CREWCUT project. For a copy of this documentation, contact Mr. John Lockett at the Army Research Laboratory Human Research and Engineering Directorate (jlockett@arl.army.mil).

IMPRINT enables you to switch missions back and forth between a VACP analysis, Goal Oriented analysis, and an Advanced Workload analysis. You can make this switch by changing the selection on the radio button at the bottom of the Mission Selection dialog.

Note that if you have a Goal Oriented mission, you will also have access to the VACP workload analysis capabilities.

VACP Function and Task List

To develop a description of the functions and tasks that make up your mission, choose the “Functions + Tasks” button from the Mission Information dialog box. When you make this selection, IMPRINT will display a list of the functions and tasks currently in the first level of the mission you selected, as shown in Figure 3-6. The name of the Mission you have selected and the Function name are displayed near the top of the dialog box. This list includes an indication of the name of each node and whether each node is a function or a task.

In addition, you will see that the leftmost column of the list is an ID. You can edit these ID’s to change the numbers of the nodes in your mission network diagram. If you do edit these values, IMPRINT has to go through all of your mission data and update all references to this node. This can take some time if you have a large mission. These ID’s are not related to the sequence of your functions and tasks. The paths you draw between the nodes determine all sequencing. The ID numbers are purely for labeling purposes. Also, a word of caution: it would be wise to save your mission just prior to renumbering. This reassignment is a complex process and saving will allow you to recover from any unanticipated changes.

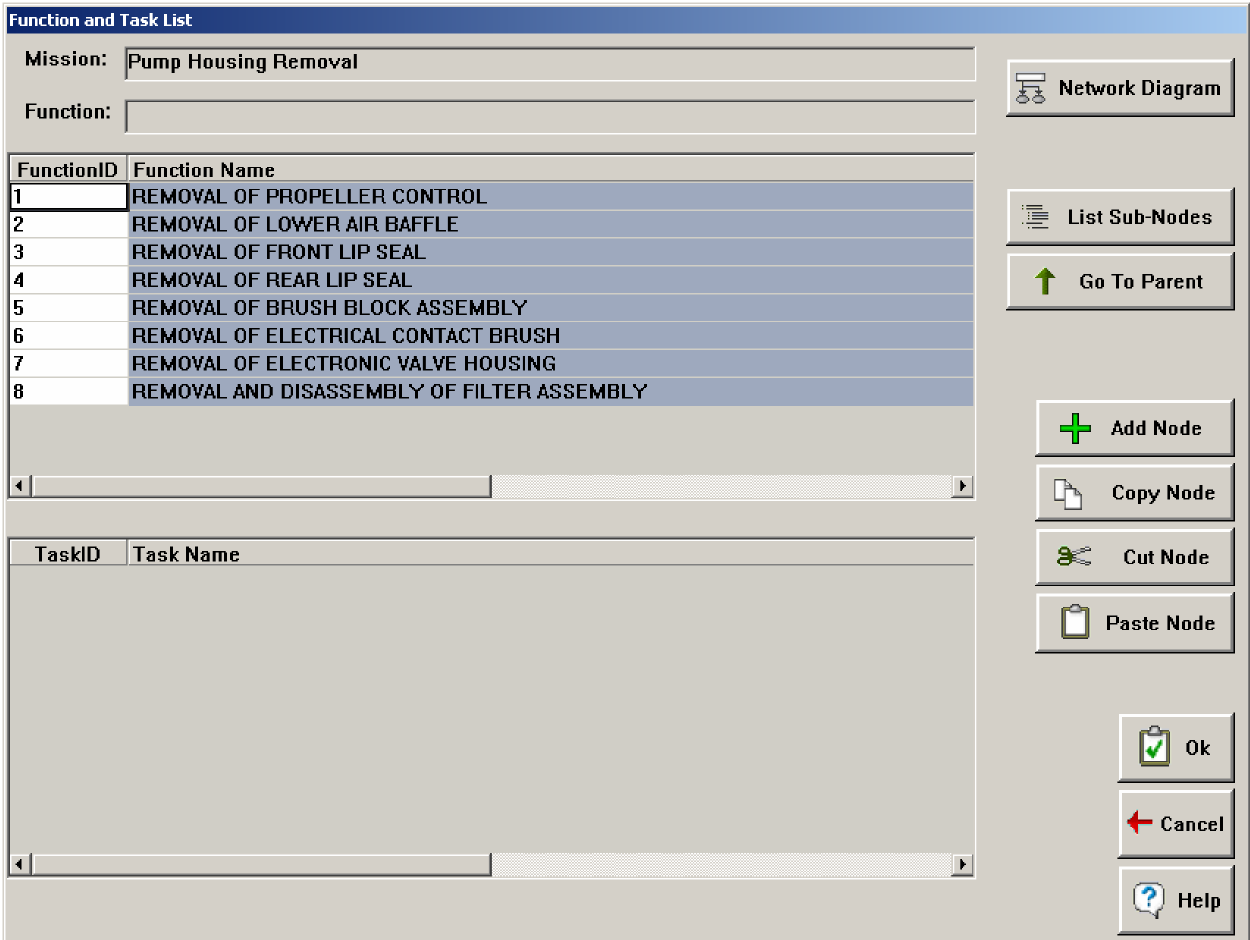


Figure 3-6. Function and Task List

This dialog box includes buttons along the right edge of the dialog box that enable you to: add, copy, cut and paste new nodes in your network. To see the Network Diagram for this mission click on the “Network Diagram” button. Selecting the “List Sub-Nodes ” button will list the functions and tasks that are members of the highlighted function. If you have highlighted a task, the “List Sub-nodes” button will have no effect.

Network Diagram Button

Clicking this button will take you to the network diagram that enables you to develop a graphical drawing of how the functions and tasks in your operational mission are related to one another. From this diagram, you can also enter the data that control the execution of your model. To enter the data, you use the select tool at the top left of the diagram tool bar and double click on the network element for which you want to enter data.

List Sub-Nodes Button

To develop a description of the functions and tasks that make up your mission, choose the “List Sub-Nodes” option from the Function and Task List dialog box. When you make this selection, IMPRINT will display a list of the functions and tasks currently in the mission you selected. The name of the Mission you have selected and the Function name are displayed near the top of the dialog box. This list includes an indication of the name of each node and whether each node is a function or a task.

This dialog box includes buttons along the right edge of the dialog box that enable you to: add, copy, cut, and paste new nodes in your network. To see the Network Diagram for this mission click on the “Network Diagram” button.

Go To Parent Button

When you click this button the parent node of the lower level node(s) highlighted will be displayed.

Add Node Button

To add a node, click on the “Add Node” button. You will get a prompt that lets you add either a function or a task to this level of your network.

Copy Node Button

To copy a node, highlight the node you want to copy and click on the “Copy Node” button. You can then use the “Paste Node” button to paste the copied node into any level of the mission network.

Cut Node Button

To delete a node, highlight the node and click on the “Cut Node” button. You can then use the “Paste Node” button to paste the deleted node into any level of the mission network.

Paste Node Button

The “Paste Node” button is used in conjunction with either the “Copy Node” button or the “Cut Node” button. You can click in the function or task list at any level of the mission network, and then click on the “Paste Node” button to paste the copied or deleted node. You can use the “Paste Node” button more than once to paste in as many copies of the node as you want.

VACP Network Diagram

The network diagram, shown in Figure 3-7, enables you to develop a graphical drawing of how the functions and tasks in your operational mission are related to one another. At the top of the drawing is the Diagram Tool bar. This tool bar is used to place and move functions and tasks on the network diagram, and to specify the paths that connect them to each other.

From this diagram, you can also enter the data that control the execution of your model. To enter the data, you use the select tool at the top left of the diagram tool bar and double click on the network element for which you want to enter data.

You will notice that the network diagram scrolls both horizontally and vertically, enabling you to enter fairly large networks. We recommend that you try to use hierarchical decomposition techniques to keep each network to a reasonable size. In IMPRINT, missions are composed of functions and tasks, and each function is itself composed of a network of tasks and functions.

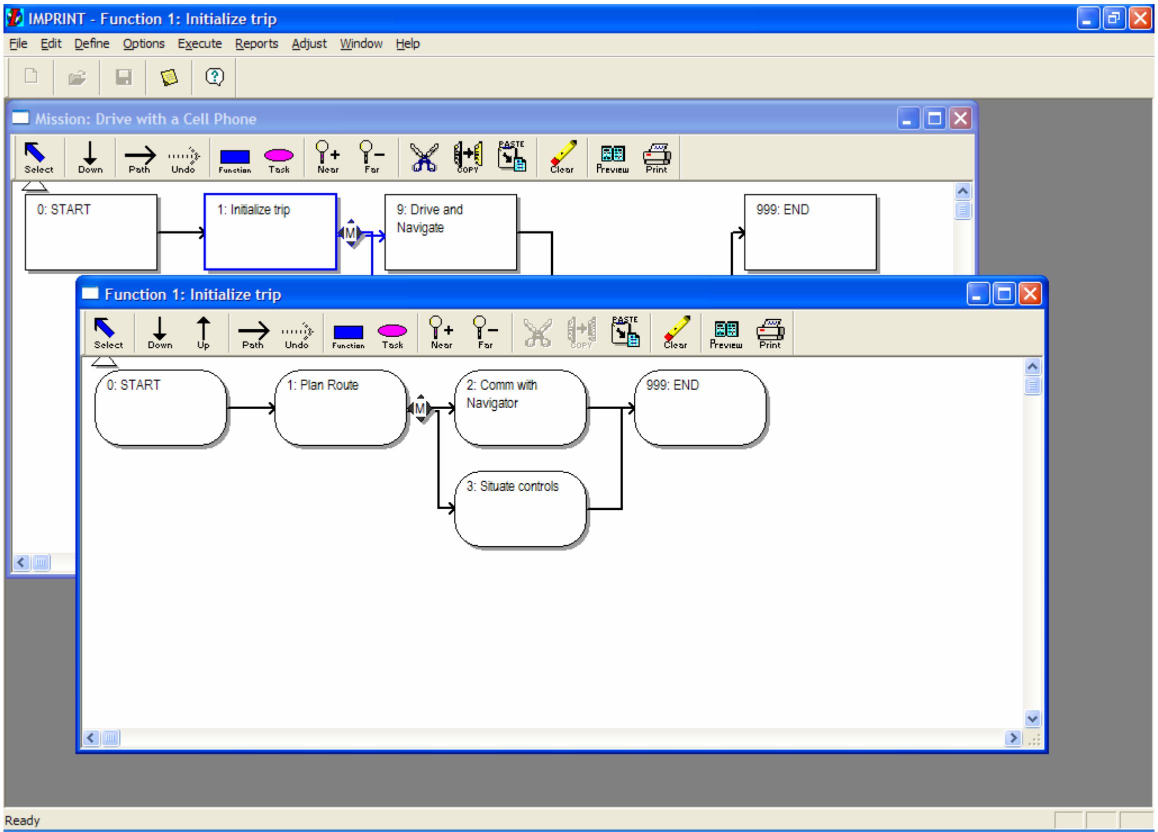


Figure 3-7. Network Diagram

Diagram Tool Bar

At the top of each IMPRINT network diagram window is a tool bar. Fifteen tools reside in the tool bar; an icon and a label represent each.

The first icon is an arrow pointing to the upper left corner of the window. This is the Select tool. When you click on this tool, and then click on an element in the diagram, the element will be selected. Selection is indicated by the element being highlighted. It can then be deleted, copied, etc. To open a network element, use the selection tool and double click.

The next icon is the down icon. An arrow pointing down with horizontal crosshatches represents this. This tool lets you go “down” into a function and open the child function’s network of tasks and functions. You cannot go “down” into a task since tasks are terminal nodes and have no networks in them. In addition, you cannot go down into a START or END function.

If you have gone “down” into a function, next is the up icon. An arrow pointing up represents this. Corresponding with the down tool, the up tool takes you to the parent function for the network currently displayed.

The path tool, represented by a right pointing arrow, is used to draw branches or paths between the nodes in your diagram. These nodes can be a mixture of functions and tasks. To draw a path, put the tool on the node you want to draw the path from and click. Hold the mouse button down while you drag the cursor to the node you want to draw the path to and then release the mouse button. If you draw more than one path from the same node, a decision diamond will automatically appear on your network diagram. Use the select tool and double click on the decision diamond to specify the branching logic associated with the multiple paths.

To delete a path on your diagram, use the undo tool. The undo icon appears as a right pointing arrow made up of dotted lines. Follow the same procedure as with the path tool, and re-trace the path you want to erase.

The function tool, a rectangular icon, will add a function to your network. Just place the tool on the diagram at the place where you want the new rectangular function to be situated and click once. IMPRINT will not let you place a function on top of another network element.

The task tool, an oval shaped icon, works similarly to the function tool. Place the tool on the diagram at the place where you want to new task to occupy and click once. IMPRINT will not let you place a task on top of another network element.

The near and far tools, each shown as a magnifying glass with either a “+” or “-“ symbol, let you zoom in and out of the network diagram. Select the tool and click on the network diagram. It will zoom in and out of the diagram view, letting you see more or less detail as it zooms.

The next four icons represent edit functions. The first tool, the scissors, is used to cut a highlighted function or task and place it on the clipboard. It can then be pasted to another area of the network.

The second editing tool, shown as two documents with an arrow between them, is used to copy a highlighted function or task and to put a copy on the clipboard so that it can be pasted elsewhere in your network.

The third editing tool is the paste tool, and is used to copy the data currently on the clipboard to the current cursor position.

The fourth editing tool, shown as a pencil eraser, is used to clear a network function or task. Data that are "cleared" cannot be pasted elsewhere in a network.

The final tools allow you to preview and to print the task network.

VACP Function Information

IMPRINT helps you break the mission down into its functions. Examples of functions are "Acquire Target," "Engage Target" and "Communicate." In addition, IMPRINT helps you identify maximum acceptable performance times for each function. Finally, IMPRINT helps you link the functions together in a network that makes up the mission.

You display the Function Information dialog box, shown in Figure 3-8, by double-clicking on a rectangle on the network diagram. This dialog contains three data elements. The first is the Function Name. This is a short description of the function, and is the label that is written into the node when the Network Diagram is displayed. The second data element is the Function Time Standard. This value is the maximum acceptable performance time for this function. The final data element is the Function Criterion. This value is the percentage of times that this function must meet its time standard to be considered successful.

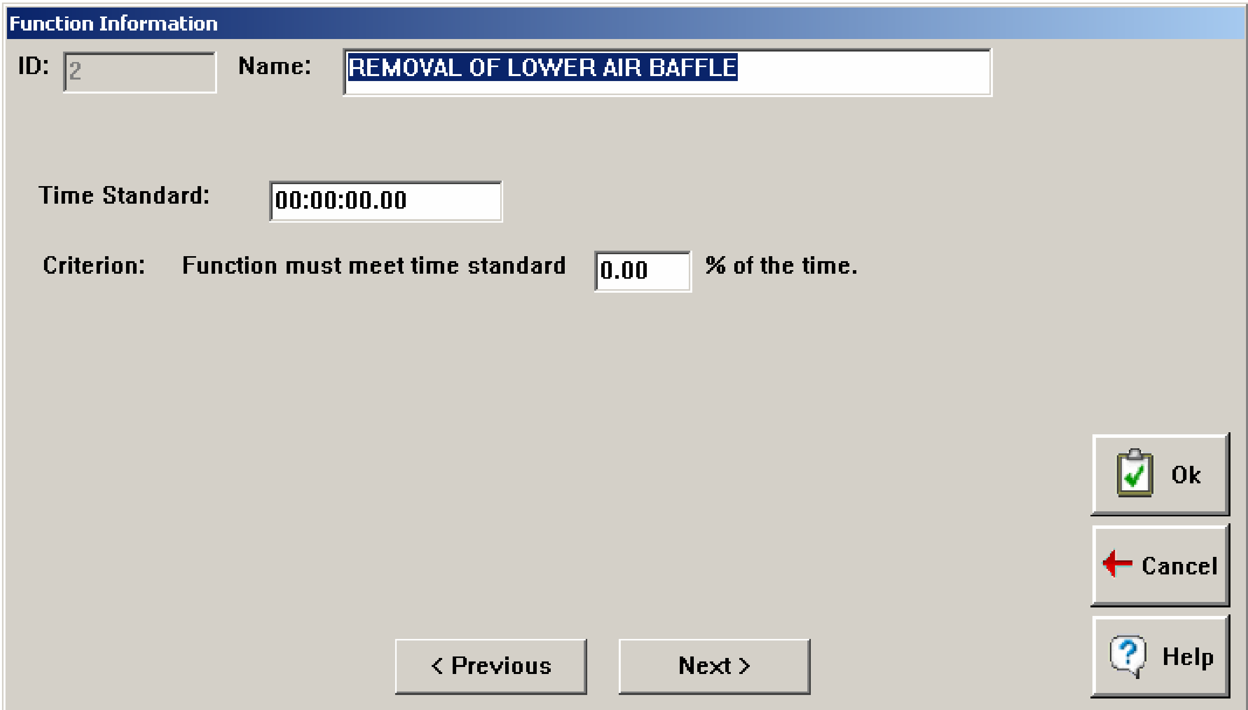


Figure 3-8. Function Information

To change the values in this dialog box, use the mouse to position the cursor in the box you want to change. Click once to set the cursor in the box, and then type in the new value. The format for the time value is hh:mm:ss.00, and the colons are required. When you first enter a screen, the format for time will be hh:mm:ss. If you edit this value, the hundredths of a second are added to the format.

The identification number (ID) for the function is also displayed on this dialog, however you must return to the function and task list if you want to change the ID. Remember that the ID's do not affect sequence, and are merely task label information. Sequence is solely determined by which paths you draw between nodes.

The "Next" and “Previous” buttons enable you to page forward and backward through the elements on the dialog box. For example, if you click on the "Next" button at the bottom of the dialog box, you will move forward one element and the information for that element will be displayed. These buttons are provided on several dialog boxes, and are intended to enable you to move through data elements more quickly and efficiently.

VACP Task Information

IMPRINT helps you break the mission down into its basic tasks. Examples of tasks are "Tune Radio," "Push Button" and "Clear Cannon." In addition, IMPRINT helps you enter the relevant data elements for each task. Finally, it helps you link the tasks together in a network that makes up the mission.

To open the Task Information dialog, double click on any task in the network diagram. The Task Information dialog box contains many data elements, and is grouped into areas that contain related information. Notice that there are tabs at the bottom of the Task Information dialog box that allow you to display Timing & Accuracy information, Effects information, Failure Consequences information, Workload information, Crew Assignment information, and finally, Taxon assignments.

At the top of each tab on the dialog box, you will see the Task Name. This is a short description of the task and is the label written in the node when the Network Diagram is displayed.

When you first enter this dialog box, you will see either the last information sheet you were in for this task or the default Timing and Accuracy information sheet. To change the type of data shown, click on the appropriate tab at the bottom of the screen. To move through the task list without returning to the network diagram, use the “Previous” and “Next” buttons at the bottom of the dialog box.

To change the values in this dialog box, use the mouse to position the cursor in the box you want to change. Click once to set the cursor in the box, and then type in the new value. The format for the time values is hh:mm:ss.00, and the colons are required. Notice that you can enter hundredths of a second after the decimal point.

The ID for the task is also displayed on this dialog, however you must return to the function and task list if you want to change the ID. Remember that the ID's do not affect sequence, and are merely task label information. Sequence is solely determined by which paths you draw between nodes.

VACP Task Timing and Accuracy

Figure 3-9 shows the first tab of the Task Information dialog. Beginning at the top of the dialog box under the task name, the first group of data displayed includes the performance standards for this task. These values define how well the task needs to be performed to be considered successful. The Task Time Standard is the maximum acceptable performance time for this task. The Task Accuracy Description is entered in two parts, a numerical part and an accuracy measure. Together, these values specify how well the task must be performed. The third data element is the Task Criterion. This value is the percentage of times that this task must meet both the time standard and the accuracy standard in the same occurrence to be considered successful.

When IMPRINT executes your mission model, the Estimated Task Mean Time, Standard Deviation, and Distribution are used to choose a specific task time for each occurrence of each task. These times are then accumulated throughout the model run and compared to the time standard in order to report the percentage of successes for each task. Similarly, the Probability of Success (calculated based on the Accuracy Mean, Accuracy Standard Deviation, and Accuracy Standard) is used to determine whether the task has succeeded or failed each time it occurs. These successes and failures are then accumulated throughout the model run in order to report the percentage of accuracy successes for each task.

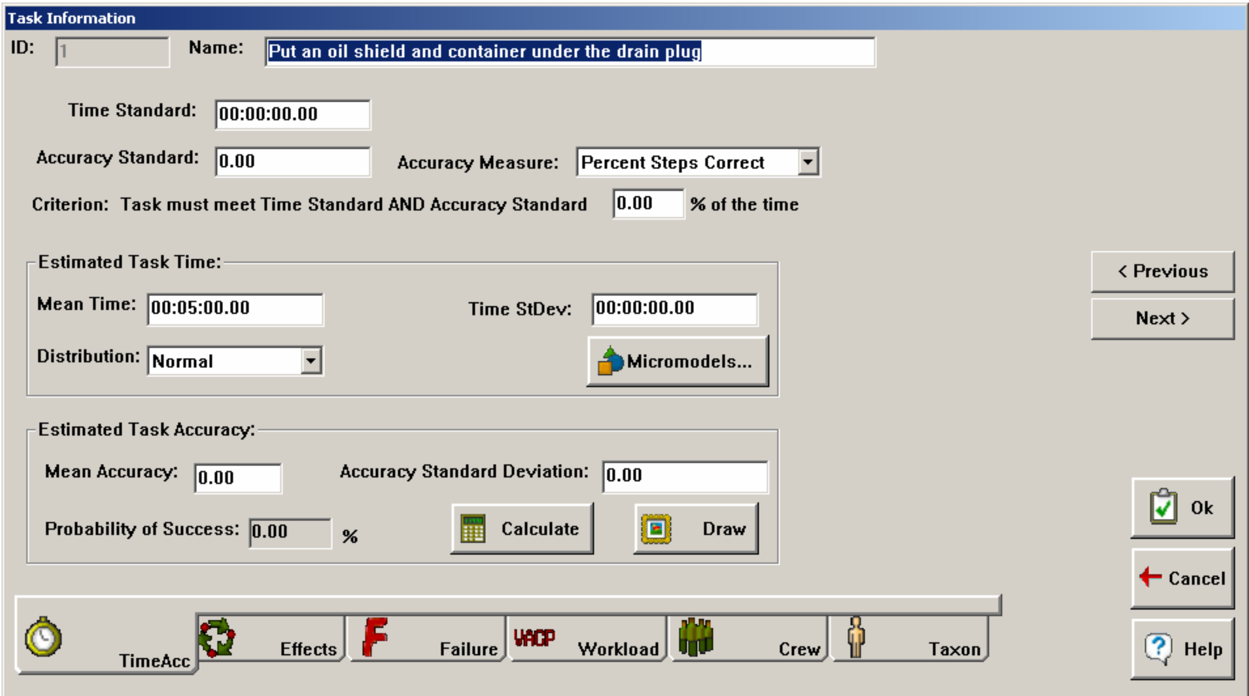


Figure 3-9. VACP Task Information Time & Accuracy Tab

The second group of data elements on this screen is three elements that describe the estimated task time. These values specify your best estimate for describing the distribution of the length of time that the task will be performed in a real environment. The first data element in this group is the Mean Time. The mean time is your estimate of the most likely, or average, task performance time. Next, you will enter the Standard Deviation. The standard deviation describes the average amount of deviation from the mean in which this task is likely to be performed. Finally, you can select a Distribution. The distribution describes the statistical distribution properties from which the actual occurrence time will be drawn. (If you are unfamiliar with statistical distributions, we recommend that you consult a statistics textbook or someone more knowledgeable in this field.) You can also access Micromodels of human performance data using the "Micromodels" button on this screen. The remainder of the information on this screen relates to the probability that this task will actually be performed to the standard specified by the Accuracy Description.

In IMPRINT, you specify the likelihood that a task will be performed accurately by entering the estimated mean and standard deviation that work together with the accuracy measure (e.g., "percent steps correct"). When the model runs, IMPRINT pulls a number from a normal distribution created with the mean and standard deviation you enter. This is compared to the accuracy standard to determine whether the task succeeded or failed its accuracy on each occurrence.

For example, you might say that on the average when performing this task the operators get 90 percent of the steps correct, or for another task they are within 10 mils of the correct azimuth. Under the first option, you will also specify the standard deviation, which is a measure of the worst and best the task is likely to be performed. An easy rule of thumb for specifying the standard deviation is to compute the difference between the worst and best performance and divide it by 6. For example, if the worst performance is 40% steps correct and the best is 100%, then an estimate for the standard deviation would be 10% (((100 - 40)/6) = 10).

We realize that it is often difficult for users to think of accuracy in these terms, and that it is often easier to think of it in terms of the probability of success. To accommodate this fact, we have provided a "Calculate" button that you can use to calculate the probability of success from the information you have entered. When you press the Calculate button, IMPRINT uses your accuracy mean and accuracy standard deviation, as well as the accuracy standard to calculate the probability of success. This is actually calculated using standard statistical procedures that compute the area under a Normal statistical curve. IMPRINT is also careful to evaluate your accuracy measure to determine whether "bigger values" are better (e.g., percent steps correct), or "smaller values" are better (e.g., mils from desired). For more information, please refer to a statistics textbook.

We have also provided access to a job aid through the Draw button on this screen. This button opens a dialog box that lets you enter three of the four data elements that are needed to specify accuracy (i.e., accuracy standard, accuracy mean, accuracy standard deviation, and probability of success), and it will calculate and display the fourth data item. In addition, it will draw the normal distribution and show the area under the curve that is used to calculate the probability of success.

To change the values in this dialog box, use the mouse to position the cursor in the box you want to change. Click once to set the cursor in the box, and then type in the new value. The format for the time values is hh:mm:ss.00, and the colons are required. Notice that you can enter hundredths of a second after the decimal point.

Micromodel Button

Click on this button to get help in estimating a task mean time. Detailed "Micromodels" are provided to help construct an overall task time. These "Micromodels" provide time estimates for performing basic activities, such as visual scanning, moving a hand from one position to another, or pushing a button. By stringing together basic activities, an overall task time (or mean task time) can be estimated.

Draw Button

We have provided access to a job aid through the Draw button on this screen. This button opens a dialog box that lets you enter three of the four data elements that are needed to specify accuracy (i.e., accuracy standard, accuracy mean, accuracy standard deviation, and probability of success), and it will calculate and display the fourth data item. In addition, it will draw the normal distribution and show the area under the curve that is used to calculate the probability of success.

Calculate Button

The calculate button uses the accuracy standard, the accuracy measure, the accuracy mean, and the accuracy standard deviation that you have entered on this screen to calculate and display the probability of task success.

Micromodels

The Micromodel dialog is shown in Figure 3-10. This capability provides access to a set of micromodels of human performance that have been gathered from the literature. Many of these micromodels are just constant values (e.g., Eye Movement Time (target is in the field)). Other micromodels include prompts for you to enter pertinent data. For example, in the Hand Movement micromodel, you enter distance to target and target size.

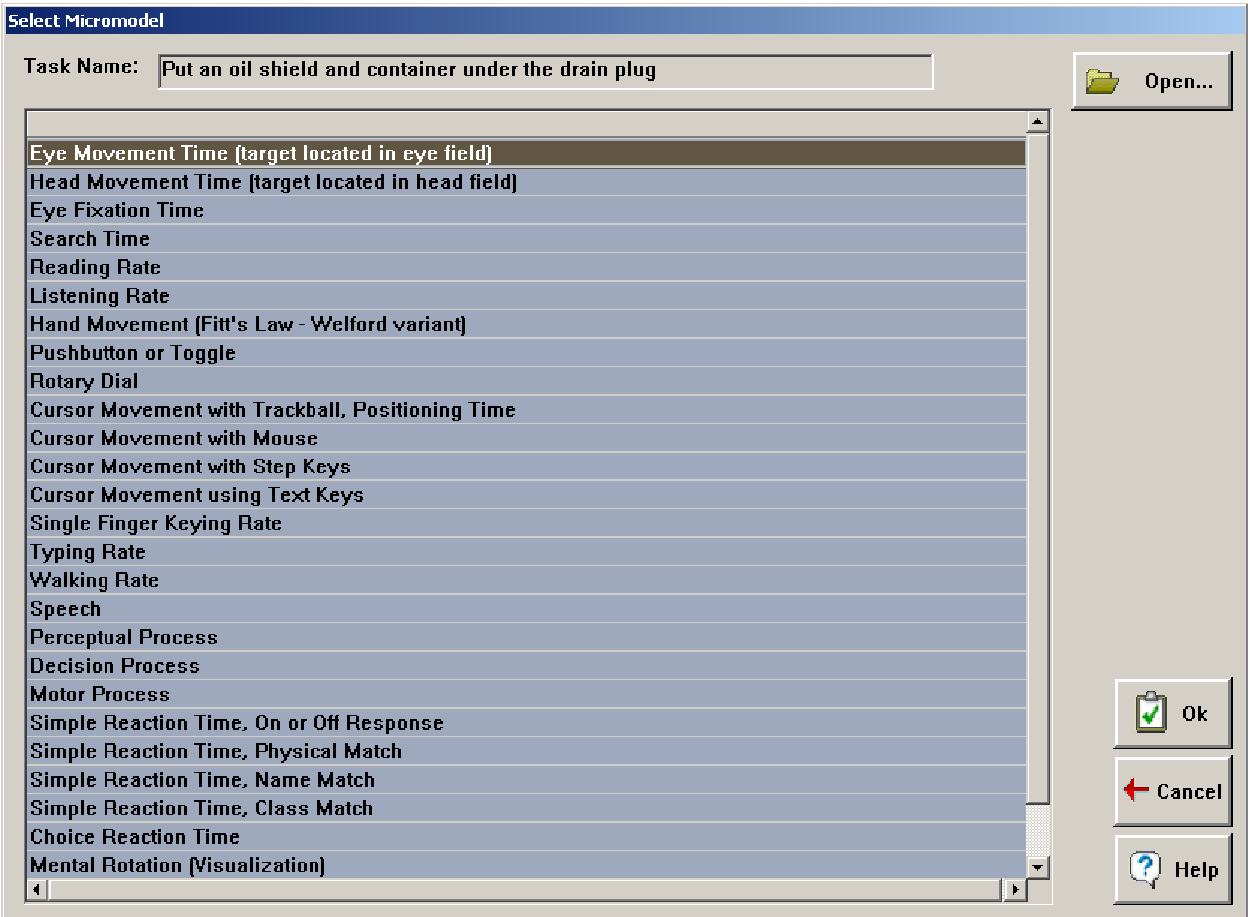


Figure 3-10. Micromodels

These micromodels are included in IMPRINT so that you can access them in order to help generate a task time estimate. The reference for each micromodel is included in the dialog, so that you can refer to the literature if you have specific questions about the assumptions behind each micromodel.

To select a micromodel, highlight it and press the “Open” button. You will be prompted to enter any parameter information that is needed. You can also see the reference for the micromodel at that time. A list of all the micromodels and their references is provided as an Appendix to this User Guide.

VACP Failure Consequences

The interface that you will see under the Failure Consequences tab is different; depending on the type of mission you are defining. Figure 3-11 illustrates the interface that is available for VACP missions.

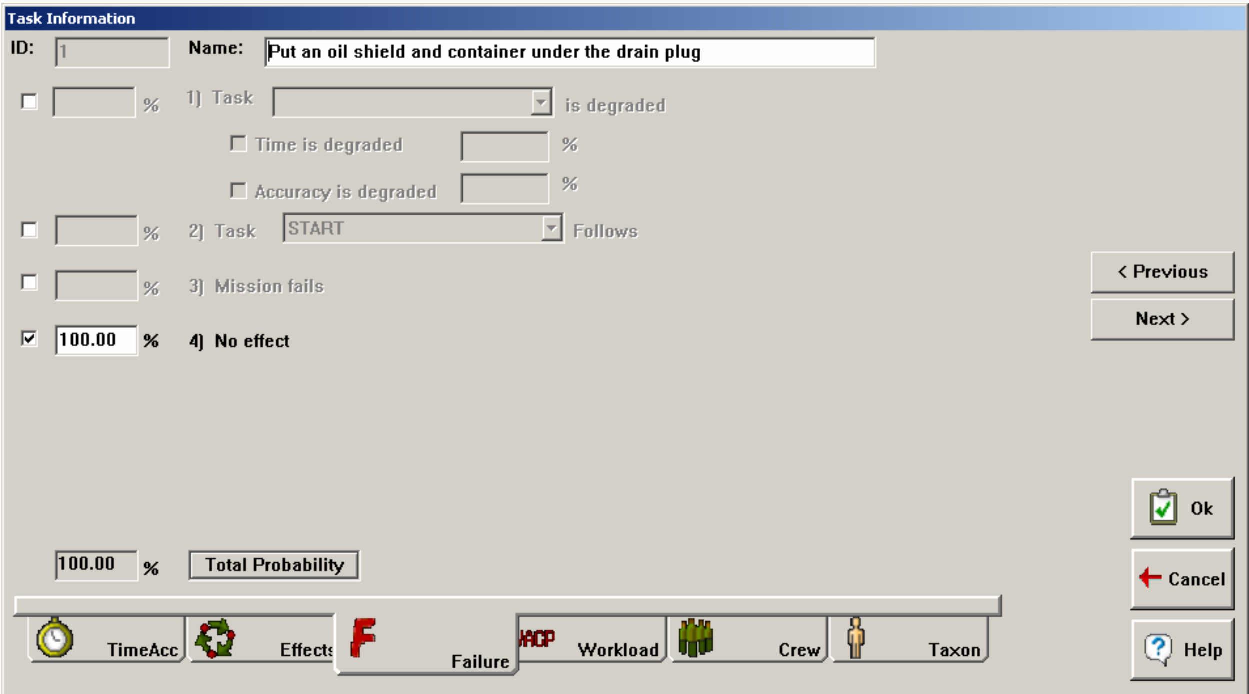


Figure 3-11. VACP Mission Interface Failure Consequences Tab

IMPRINT provides several possible consequences of task failure due to accuracy from which you can choose. These include changing the following task, causing the mission to abort, having no effect, and changing the time or accuracy on another task. If you are modeling an Advanced Mission, you will also have access to a consequence that changes the operator assigned to a task. You can assign probabilities to each of these consequences. When IMPRINT runs, if a task fails to meet its definition of success, it will pull a random number from its stream and will use that to determine which failure consequence will be implemented.

If you choose to use the effect that assigns a different following task in the event of failure, make sure that you do not assign a rejoin task as the new following task. This will cause the model to run incorrectly. For more information, refer to multiple decision types.

Workload

This dialog, shown in Figure 3-12, is only accessible if you are working on a VACP or Goal Oriented mission. In the VACP method, the workload estimates are described using four channels: visual, auditory, cognitive, and psychomotor. You select the workload level for each channel by selecting the appropriate row in the pull down list in the respective work scale of Visual Workload Scale, Auditory Workload Scale, Cognitive Workload Scale, and Psychomotor Workload Scale.

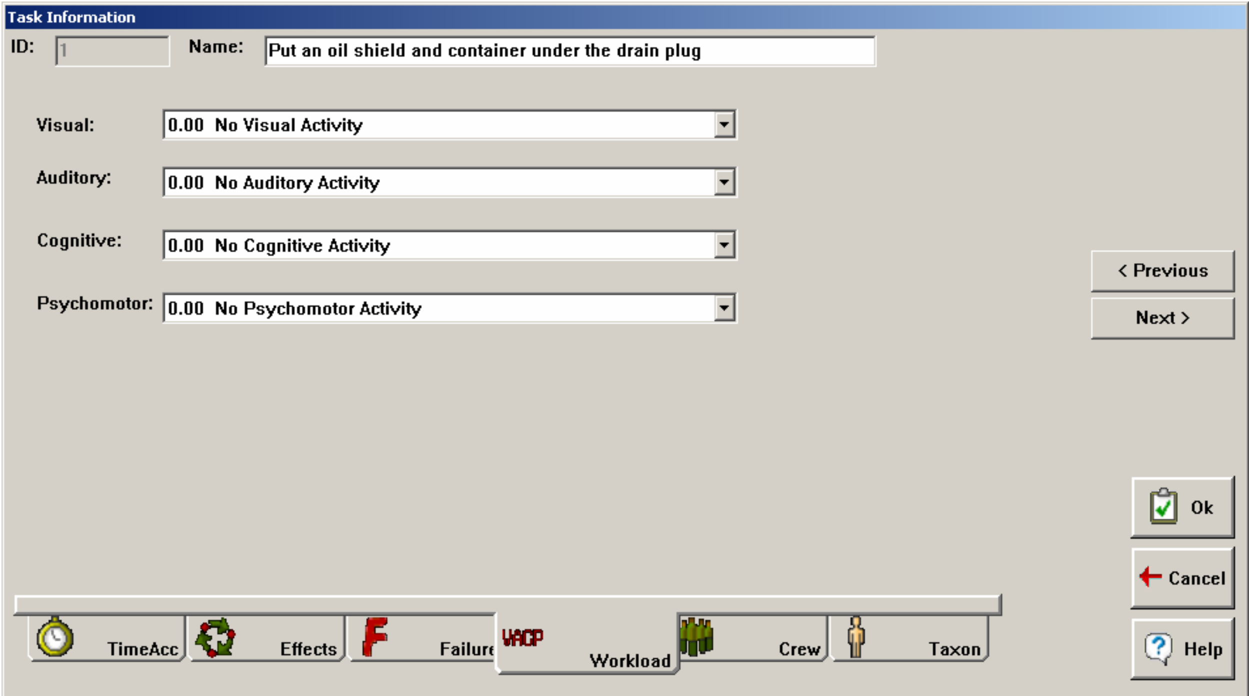


Figure 3-12. Task Information Dialog Workload Tab

The VACP workload theory that we have implemented in IMPRINT is discussed in detail in an Army Research Institute Technical Report (McCracken and Aldrich, 1984). We will discuss the basics of that report here, but if you want to learn more about this theory we recommend you consult that technical report.

Workload theory is based upon the idea that every task a human performs requires some work. Usually a task is composed of several different types of work, such as visual or cognitive. As an example, consider a task like steering a car. This task will have some visual work (watch where you are going), some cognitive work (decide if you are turning enough), and some psychomotor work (rotate the steering wheel). The workload theory in IMPRINT helps you assign values representing the amount of effort that must be expended in each channel in order to perform the task. To help you, IMPRINT displays a list of scale values and descriptors for each channel. These scales are taken directly from Bierbaum, Szabo, and Aldrich (1989).

If you are not sure precisely how to rate a task, we recommend that you rate the task on the high side, rather than too low. As you will see in the reports, IMPRINT will show you the workload peaks as the mission progresses. If, at that time, you see that one of your "questionable" workload ratings has led to a peak, you can investigate the task further to determine whether it is likely to lead to a problem in the "real world."

This theory also hypothesizes that if you are doing two tasks at once, the workload levels are additive within channels, across tasks. For example, if you were doing two tasks at once, one with a psychomotor load of 2.6 and one with a psychomotor load of 4.6, then IMPRINT would record a psychomotor score of 2.6 + 4.6 = 7.2 for the time that the two tasks were being performed together. The value of each workload channel throughout the mission will be displayed for you in a graph in the reports. From this graph, you will be able to pick out the times during your mission that the workload "peaked." In addition, the graph will tell you what each operator was doing during these peaks so you can pinpoint the tasks that contributed to high workload for each operator.

Visual Workload Scale Combo Box

The visual workload scale embedded in the VACP missions in IMPRINT is shown below:

SCALE VALUE	VISUAL SCALE DESCRIPTOR
0.0	No Visual Activity
1.0	Visually Register/Detect (detect occurrence of image)
3.7	Visually Discriminate (detect visual differences)
4.0	Visually Inspect/Check (discrete inspection/static condition)
5.0	Visually Locate/Align (selective orientation)
5.4	Visually Track/Follow (maintain orientation)
5.9	Visually Read (symbol)
7.0	Visually Scan/Search/Monitor (continuous/serial inspection, multiple conditions)

Auditory Workload Scale Combo Box

The auditory workload scale embedded in the VACP missions in IMPRINT is shown below:

SCALE VALUE	AUDITORY SCALE DESCRIPTOR
0.0	No Auditory Activity
1.0	Detect/Register Sound (detect occurrence of sound)
2.0	Orient to Sound (general orientation/attention)
4.2	Orient to Sound (selective orientation/attention)
4.3	Verify Auditory Feedback (detect occurrence of anticipated sound)
4.9	Interpret Semantic Content (speech)
6.6	Discriminate Sound Characteristics (detect auditory differences)
7.0	Interpret Sound Patterns (pulse rates, etc.)

Cognitive Workload Scale Combo Box

The cognitive workload scale embedded in the VACP missions in IMPRINT is shown below:

SCALE VALUE	COGNITIVE SCALE DESCRIPTOR
0.0	No Cognitive Activity
1.0	Automatic (simple association)
1.2	Alternative Selection
3.7	Sign/Signal Recognition
4.6	Evaluation/Judgment (consider single aspect)
5.3	Encoding/Decoding, Recall
6.8	Evaluation/Judgment (consider several aspects)
7.0	Estimation, Calculation, Conversion

Psychomotor Workload Scale Combo Box

The psychomotor workload scale embedded in the VACP missions in IMPRINT is shown below:

SCALE VALUE	PSYCHOMOTOR SCALE DESCRIPTOR
0.0	No Psychomotor Activity
1.0	Speech
2.2	Discrete Actuation (button, toggle, trigger)
2.6	Continuous Adjustive (flight control, sensor control)
4.6	Manipulative
5.8	Discrete Adjustive (rotary, vertical thumbwheel, lever position)
6.5	Symbolic Production (writing)
7.0	Serial Discrete Manipulation (keyboard entries)

VACP Crew Assignments

The interface you see when you click on the Crew Assgn tab varies, depending on your mission type. Figure 3-13 illustrates the VACP interface.

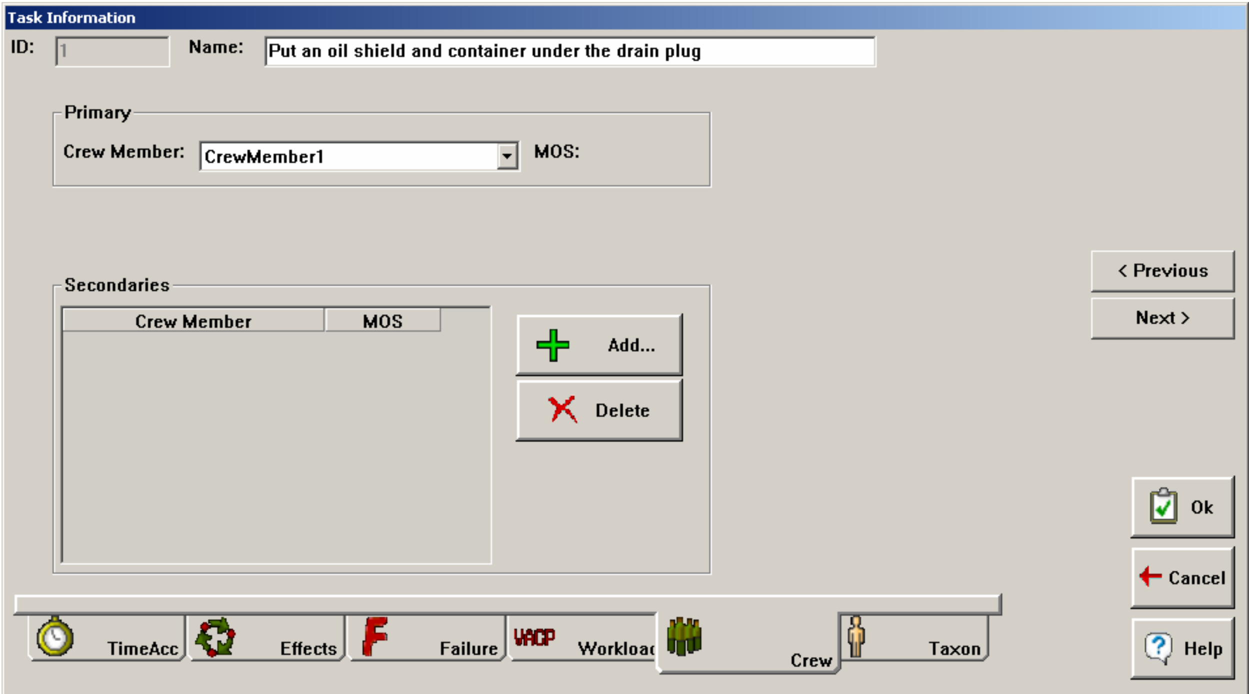


Figure 3-13. Crew Assignments

The operator assignments consist of four fields that are used to describe each crewmember. The fields are the crew member, MOS, or Military Occupational Specialty, and whether this is a Task Primary Operator assignment or a Task Secondary Operator assignment.

You select the MOS for this task by clicking on the down arrow with a line under it to the right of the MOS field. Clicking on the down arrow will provide you with a list of possible MOS assignments for this task. The list of MOS' would have been defined in the "Define Soldier" portion of IMPRINT.

The crewmember is selected in the same manner as for selecting the MOS. You click on the down arrow to the right of the crewmember field and a list of possible crewmembers will be displayed. Simply click on the desired crewmember.

Taxons

Taxons provide a method for you to describe the composition of your task. Taxons are used in IMPRINT to adjust estimated task times and accuracies when you apply Personnel Characteristics, Training Frequency or Stressor adjustments. If you do not want to enter taxons, but you have already entered workload assignments, AND you have a VACP or Goal Oriented mission open, then you can use the Map Workloads to Taxons capability under the Options menu.

The taxons are grouped into four areas, as shown in Figure 3-14. These four taxon areas are perceptual, cognitive, motor and communication. You will give taxon weight values ranging from 0.0 to 1.0 to these taxons with the sum of the taxon weights being less than or equal to 1.0. At most, three taxon weights can be used.

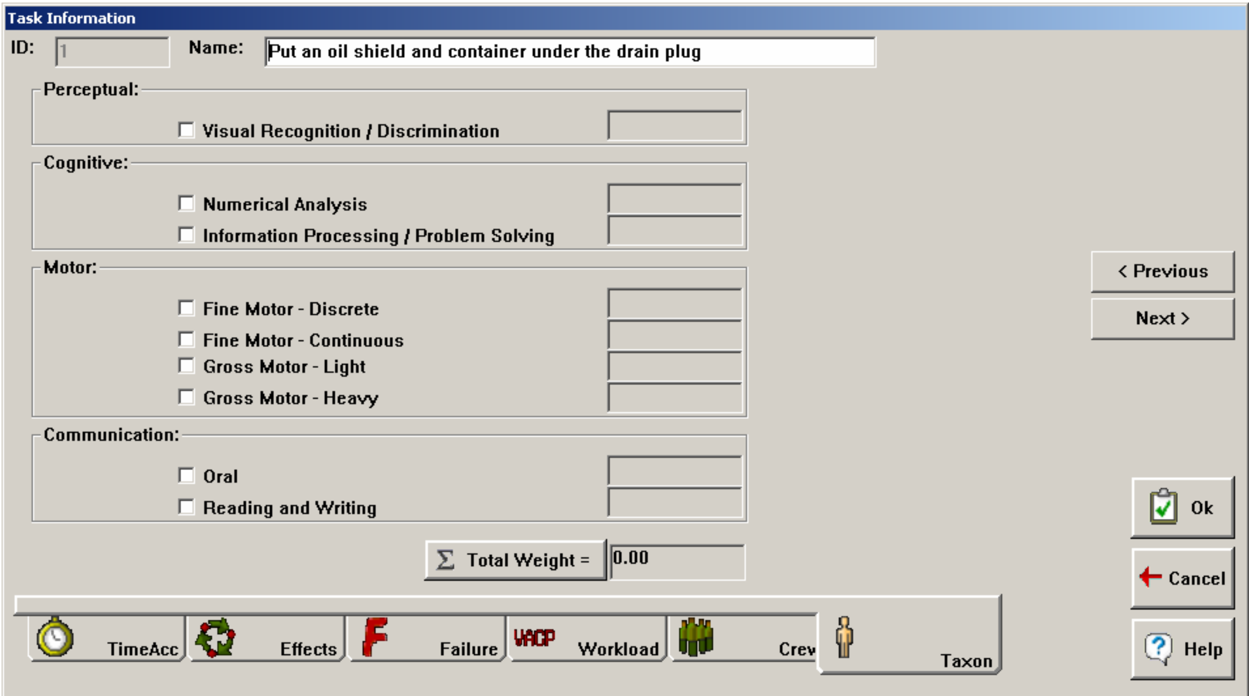


Figure 3-14. Taxons

The perceptual taxon has one category, and that is visual recognition/discrimination.

The cognitive taxon is broken down into two categories: numerical analysis and information processing/problem solving.

The motor taxon has four categories: fine motor-discrete, fine motor-continuous, gross motor-fine, and gross motor-heavy.

The communication taxon is broken down into two categories: oral, and reading and writing.

At the bottom of the screen is a button labeled Total Weight. You can click on this at any time to sum the weights of the taxons currently described.

More information on the taxons and how they are used in the modeling to change task level performance is available in a technical paper provided in Appendix A to this document.

VACP Decision Types

When you draw paths between nodes on the network diagram, you will begin the process of identifying a decision type for each of the nodes in your network. If you draw more than one path from a node, a decision diamond will display. If you double click on the decision diamond, you will see the interface shown in Figure 3-15.

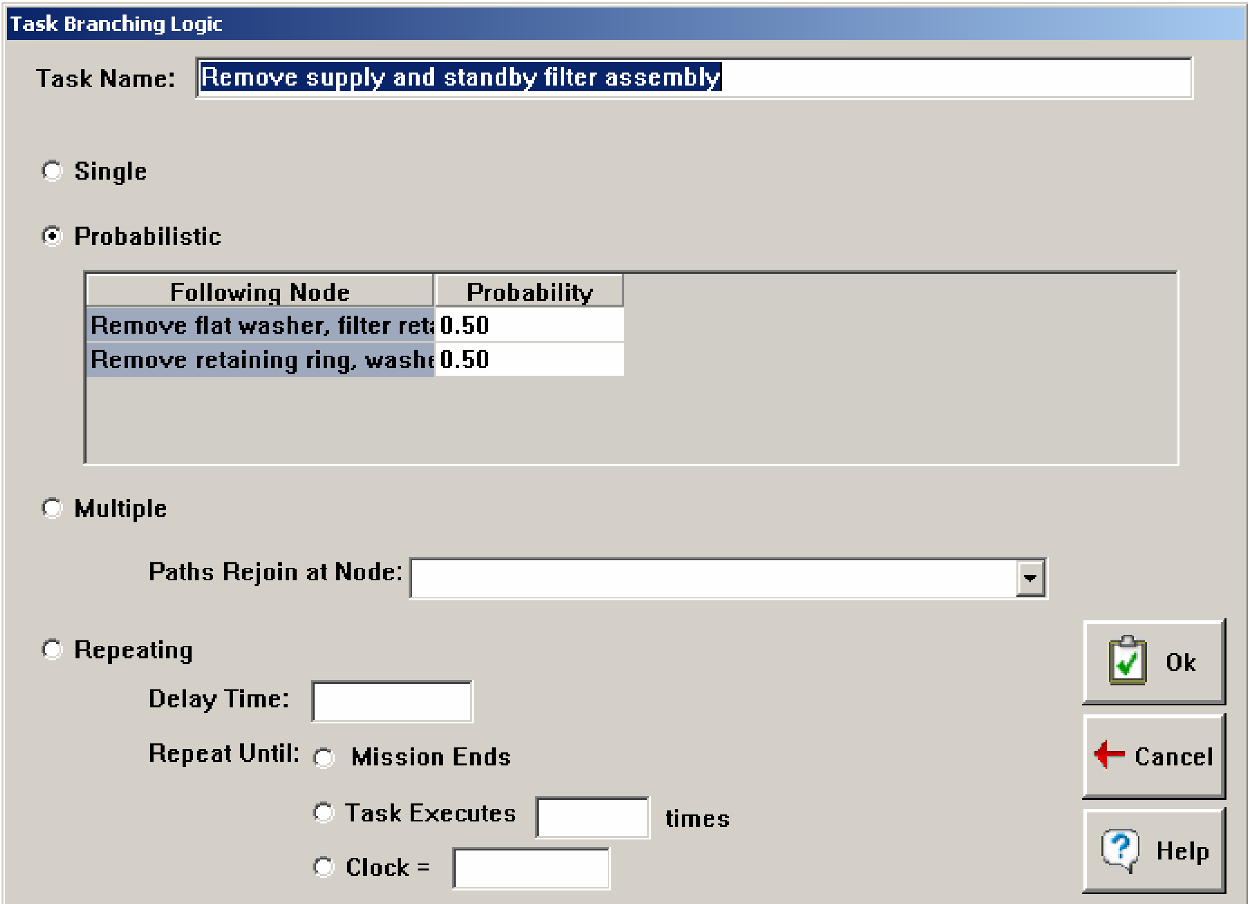


Figure 3-15. VACP Task Branching Logic

The possible decision types are as follows:

- Single - The same node always follows this one.
- Probabilistic - More than one node will follow this one. Each following node has a probability of being selected. The sum of the probabilities must equal 100 percent.
- Multiple - More than one node will begin as soon as this one is completed. All following nodes will begin performing at the same time. You must specify a Rejoin Node for all multiple decisions.
- Repeating - This node will repeat itself before going on to its following node. There are three types of repeating nodes. You can select whether the node repeats a specific number of times, whether it repeats until the clock reaches a specific time, or whether it repeats until the simulation ends. To specify a repeating decision type, you must draw a single path from the node back to itself, and one path to the node that will follow it once the repeating is complete (often, this will be the “END” node)

Dummy Nodes

Sometimes it is convenient to use "dummy" nodes to clarify the flow of your mission. These dummy nodes can be either functions or tasks that will act as placeholders in the function or task list and in the sequence. If you add a dummy function, you must also add a dummy node to that function. By not assigning times to these nodes, they will not take any time in the mission simulation model and thus will not have an effect. It is for this reason that some of the functions and tasks in the library models have a performance time estimate of 0 minutes.

Rejoin Nodes

If you specify a multiple decision type, and you are defining a VACP mission, then you will need to enter where these multiple paths will rejoin. IMPRINT requires that the paths come back together at a single node. This requirement ensures that the simulation model will wait for all the parallel functions to finish before it proceeds to the next function. An example of a multiple decision is shown in Figure 3-16.

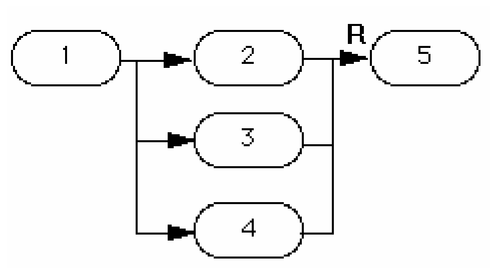


Figure 3-16. Example of a Multiple Decision

In this example, Task #1 has a multiple decision. Its following tasks are tasks #2, #3, and #4. All these paths rejoin at Task #5. Let's look at an example that is a bit more complex, as shown below in Figure 3-17

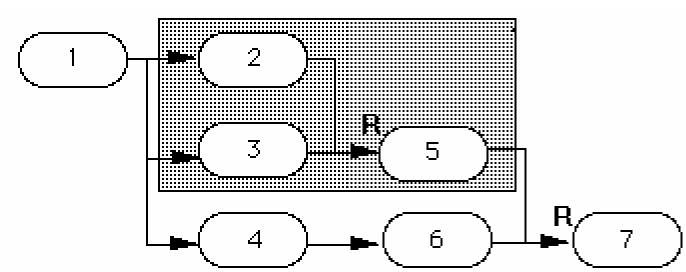


Figure 3-17. A Multiple Decision Following a Multiple Decision

In this example, Task #1 has a multiple decision. Its following tasks are the same as before, #2, #3, and #4. However, in this example tasks #2 and #3 rejoin at #5, and this path does not rejoin the path through #4 until #4 passes through #6 and rejoins at task #7. In order for IMPRINT to understand how to correctly manage this network, you will have to change it so that all parallel paths from a single task meet together at the same task. You would have to insert a new "dummy" task as shown by task #8 in Figure 3-18.

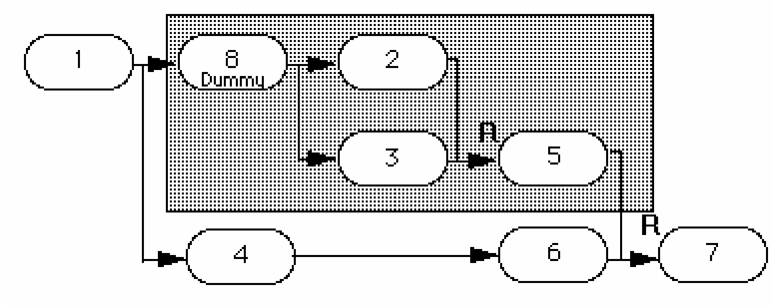


Figure 3-18. Use of Dummy Task

Now, task #1 still has a multiple decision. It goes to our new "dummy" task #8 and our original #4. Dummy tasks are tasks that perform no functional purpose for the model but do help you to solve problems like this one. Dummy tasks take no time to execute and have no effect on the performance of your model as long as you do not assign any tasks to the dummy task. In effect, they will be invisible to your mission. Now, the multiple paths from Task #1 rejoin at #7. Task #8 (our dummy) also has a multiple decision. It goes to #2 and #3. These paths rejoin at #5.

There are some subtle issues associated with making your network rejoin correctly. As the network executes, the rejoin node is instructed to wait until all the incoming paths are traversed before it releases. As each line coming into the rejoin node is traversed, it is counted. When the same number comes in as were sent out by the multiple decision branches, the rejoin is released. For this reason, you should not identify a rejoin node as a “different task following” failure consequence. This is because, when that consequence is triggered, the network will “jump” to the rejoin task to attempt to start it and will not traverse the incoming path. Therefore, the counter will not be decremented properly. You can make this operate properly by inserting a dummy node immediately prior to the rejoin node, and use that node as your “different task following” task. Then, the incoming path to the rejoin will be traversed as needed.

The best way to determine whether the rejoin tasks are correctly identified in your model is to execute the model in the Animated mode. You can “single step” the animated presentation as the icons move through the network (use Ctrl t for single stepping). If you notice that the rejoin nodes are either not waiting for all the incoming paths to complete or if you receive the Micro Saint error “Task XX can never be released,” then you have a rejoin problem. An additional way to determine whether your rejoins are correct is to study the Task Performance Report to make sure that the number of occurrences on every task is correct. If you have tasks that are occurring too many times in your mission, it is probably because the rejoin data are incorrect.

Crew

The interface you will see when you access this capability is different, depending on your mission type. The VACP Crewmember definition interface is shown in Figure 3-19.

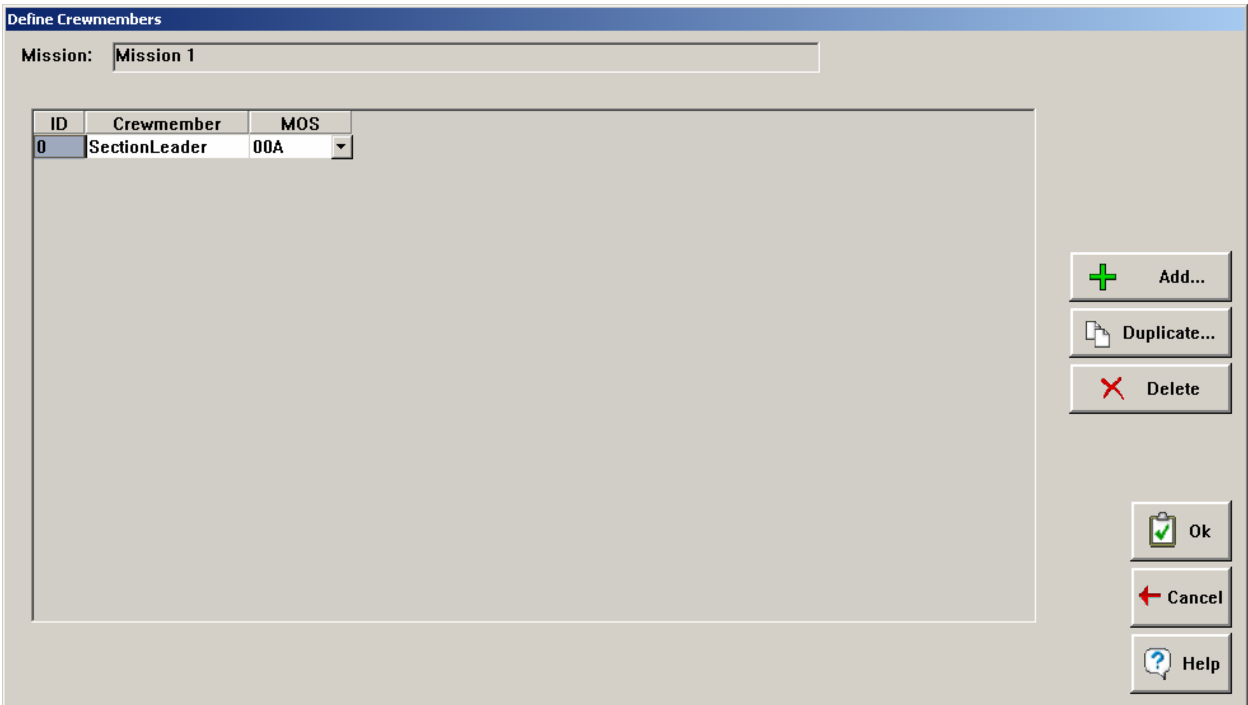


Figure 3-19. Define Crewmembers

Use this interface to add, duplicate and delete the names of the crewmembers to whom you will assign tasks in this mission. Adding an operator MOS will be discussed later in the Define Soldiers section of this user guide.

Equipment

The objective of the Define Equipment module is to help you estimate maintenance man-hour requirements for your system. You can access this capability through the "Equipment…" option from the "Define" menu.

This module lets you enter parameters that control such items as the maintenance manpower pools, the spare availability, and the combat damage potential. These parameters, coupled with a mission schedule and the data describing the maintenance actions that your system may need are combined in a stochastic maintenance simulation. The primary purpose of the simulation is to predict the maintenance man-hours required to attain an acceptable system availability.

To begin developing a description of the system equipment, choose the "Equipment..." option from the "Define" menu. When you make this menu selection, IMPRINT will display the Analysis Name along with a list of the equipment currently in the working database for the system you selected, as illustrated in Figure 3-20. This list also includes the date you last made changes to each piece of equipment.

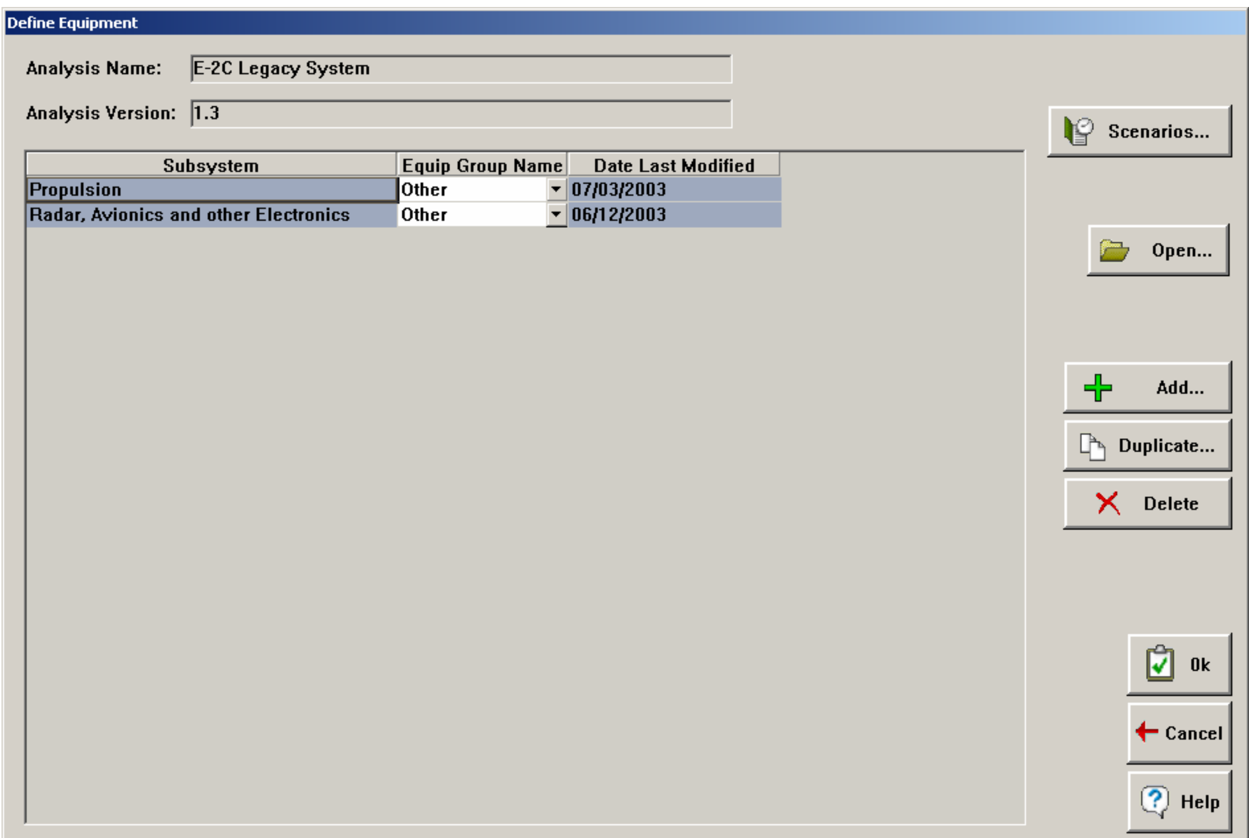


Figure 3-20. Define Equipment

To conduct an IMPRINT analysis of the maintenance man-hour requirements to support a particular system, you will need to perform three basic activities.

(1) You will need to describe the maintenance requirements for the system by specifying the following information for each component system:

- How often the component needs to be maintained (i.e., rounds fired, time operated)
- The type of maintenance task that needs to be performed (remove & replace, repair, inspect, troubleshoot, etc.)
- The type and number of maintainers that are needed to perform the maintenance task
- How long it will take to perform each maintenance task
- Whether the maintenance is preventive or corrective
- The maintenance organizational type at which the task needs to be performed (e.g., ORG, DS, GS)
- Whether a contact team could perform the maintenance
- Whether a crew chief could perform the maintenance

This information will be contained in the IMPRINT "Define Equipment" dialog spreadsheet with a row for each maintenance task and a column for each of the maintenance parameters listed above. The data in the spreadsheet will be used as input to the IMPRINT maintenance simulation model.

If you are using IMPRINT to evaluate the maintenance requirements for a proposed new system in the acquisition cycle, you can enter the component maintenance parameters from scratch or from a system design. However, it is more likely that you will begin by copying maintenance parameters from a similar library system and then modifying existing components and/or adding new components to reflect the system you are trying to evaluate.

If you are using IMPRINT for a different purpose, such as unit design, you may want to simply copy a library system and use it as is, using the same components and maintenance actions and modifying only the types of maintainers, maintenance levels, or other parameters for the existing components.

(2) The next activity you will perform will be to build a simulation scenario that will define the conditions under which the system you are modeling will be used and the amount of usage the components in each system will incur. Scenario segments will determine subsystem usages and probabilities for combat damage. Each scenario can contain multiple segments.

(3) The final activity you will perform to prepare for the IMPRINT maintenance simulation run will be to define the unit configuration and support parameters for each scenario. These parameters include:

- Operational crew (per system) - This is an optional parameter, and the information defaults to an empty set of operational crew members.

- Maintenance shift manning (size, type) - This parameter defaults to the minimum possible shift manning, as well as one shift per day that is eight hours long. IMPRINT calculates the minimum shift manning by examining each maintenance task to find the minimum number of people in each specialty that will enable any given task to be performed.

- Spare parts (availability, wait times) - This is also an optional parameter and is specified at the subsystem level. This parameter defaults to 100% availability, and a zero wait time.

This spreadsheet lists all the major subsystems for the system that you are analyzing. A major subsystem is typically something like an engine, landing gear, or main gun. The second column of the spreadsheet contains the equipment type. There are three possible equipment types. They are Armaments, Mobility, and Other.

The equipment type of each subsystem determines how the usage will be accrued to each component in the subsystem and the basis on which each component will require maintenance. Armaments subsystems will accrue usage and require maintenance based on rounds fired from that subsystem. Mobility subsystems will accrue usage and require maintenance based on the distance traveled by the system. Other subsystems will accrue usage and require maintenance based on the operational time.

From this screen, you can open a subsystem and begin entering maintenance task data, or you can define the scenarios under which this system will operate.

Scenario Button

Clicking on this button allows you to develop scenarios for the maintenance model.

Open Button

Clicking on this button opens a dialog that lists the components that are members of the subsystem highlighted.

Add Button

Clicking on the “Add” button allows you to type in the name of an additional subsystem. For the additional subsystem to impact the maintenance model, you must also provide component data.

Duplicate Button

Clicking on the “Duplicate” button will produce another subsystem with all its data exactly like the subsystem that is highlighted in the spreadsheet. You should give the replicated subsystem a name that is different than the original subsystem.

Delete Button

Clicking on the “Delete” button will delete the highlighted subsystem in the spreadsheet. It will also delete all the information associated with that subsystem, such as all components and repair action data.

Components

The Subsystem Components screen shown in Figure 3-21 is accessed through the Subsystem List by highlighting the subsystem for which you want to add or review data, and clicking on the “Open” button. Use this spreadsheet to enter a list of all the components in the selected subsystem, using the “Add,” “Duplicate,” and “Delete” buttons. After you have entered the components, press the "Repair Tasks" button to enter the maintenance tasks and associated data for each component.

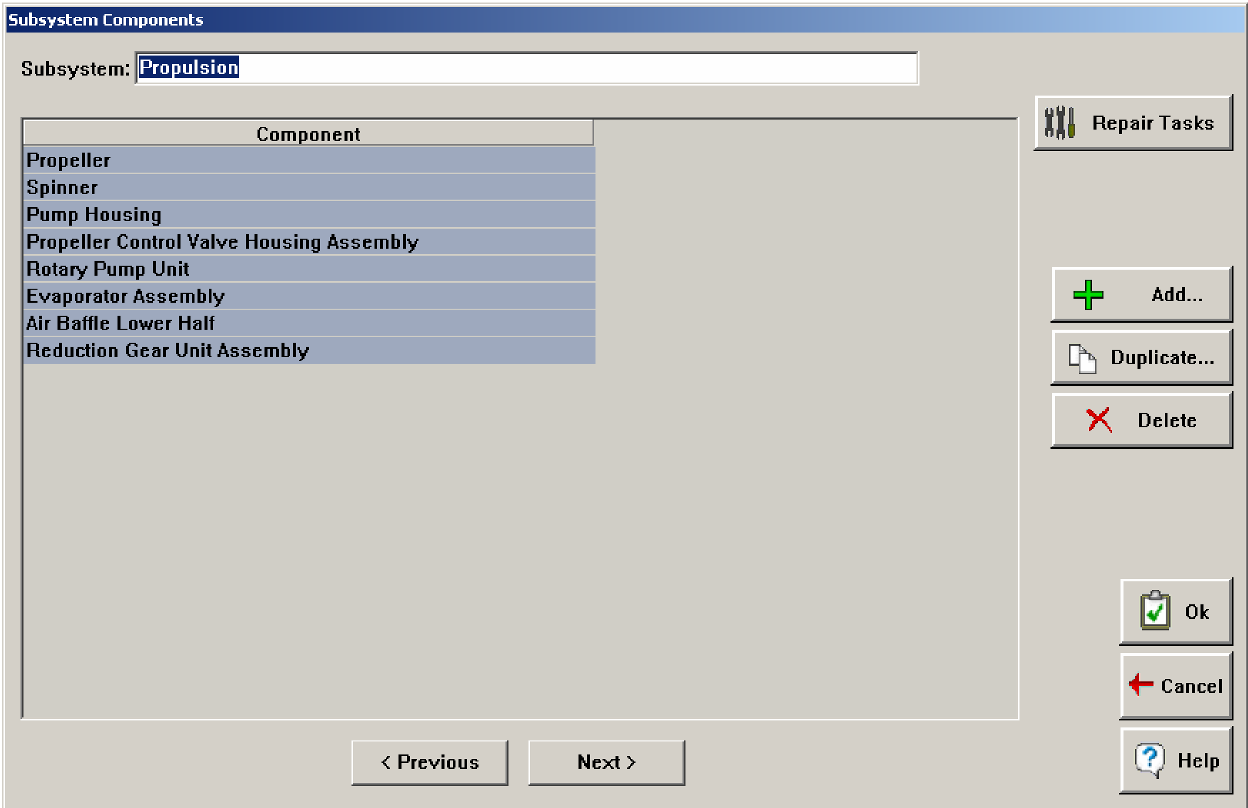


Figure 3-21. Subsystem Components

Use the "Previous" and "Next" buttons to progress through the list of subsystems.

Add Button

Clicking on the "Add" button allows you to type in the name of an additional component. For the additional component to impact the maintenance model, you must also provide component data.

Duplicate Button

Clicking on the "Duplicate" button will produce another component with all its data exactly like the component highlighted in the spreadsheet. You should give the replicated component a name that is different than the original component.

Delete Button

Clicking on the "Delete" button will delete the highlighted component in the spreadsheet. It will also delete all information associated with that component, such as repair action data.

Repair Tasks Button

Click on this button to enter or edit maintenance data for all repair tasks associated with the components you have highlighted.

Repair Task Data

The dialog shown in Figure 3-22 is displayed when you click on the Repair Tasks button.

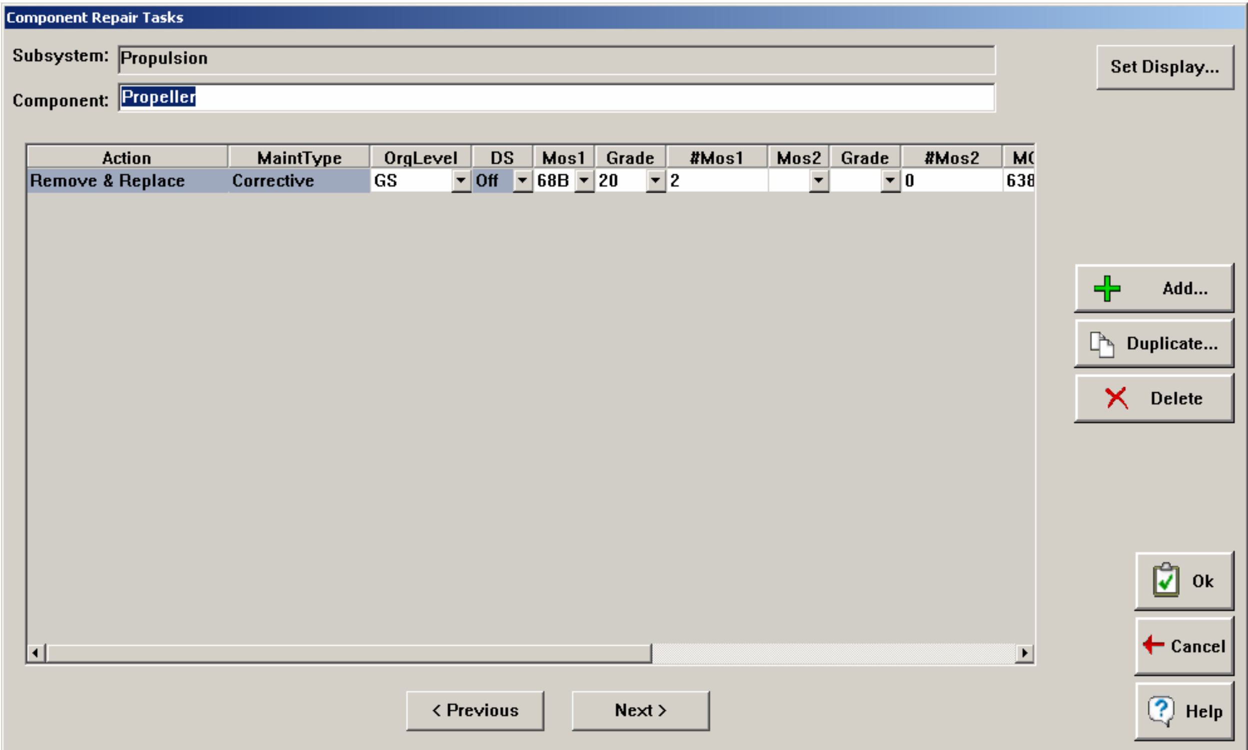


Figure 3-22. Component Repair Tasks

Each component could require several possible maintenance actions. The parameters shown in columns to the right of the "Action" column are the maintenance parameters for each maintenance action. In other words, each row of the spreadsheet represents the maintenance parameters for one maintenance action.

The horizontal scroll bar at the bottom of the task spreadsheet lets you scroll to the right to view columns that will not fit into the window. The following is a description of each column.

Action - There are several possible maintenance actions to choose from. These include Adjust & Repair, Inspect, Remove & Replace, Test & Check and Troubleshoot.

Maint Type - There are two types of maintenance actions, preventive and corrective. Preventive maintenance is scheduled at fixed intervals. However, it is only performed at times when the system is not on a combat mission. Corrective maintenance is required when a component fails because of usage or combat damage.

OrgLevel - This is an indication of the maintenance level that will perform the maintenance action. There are three possible maintenance levels:

- Organizational (ORG)
- Direct Support (DS)

- General Support (GS)

You can edit the names for the maintenance levels under the “Options” menu, “Edit Org Levels” item.

DS – Direct Support maintenance can either be performed “On Equipment” or “Off Equipment.” On equipment maintenance makes the system unavailable during the time that maintenance is being performed. An example of an on equipment task is changing a tire or a filter. Off equipment maintenance are repairs that are performed once a part has been removed from the system. The system itself remains available for missions. An example of an off equipment task is fixing a hole in a tire after you have already replaced the tire with a spare. All Org level maintenance is assumed to be performed “On Equipment.” All GS level maintenance is assume to be performed “Off Equipment.”

MOS 1 - This is the first Military Occupational Specialty that is required to perform the maintenance. In most cases, only one MOS is needed.

MOS 1 Grade - This is the skill level for MOS 1. Skill levels include 10, 20, 30, 40, or 50.

- This column contains the number of maintainers of MOS 1 that are required to perform the maintenance.

MOS 2 - This column is used if a second MOS is required to perform the maintenance action.

MOS 2 Grade - This is the skill level for MOS 2. Skill levels include 10, 20, 30, 40, or 50.

- This column contains the number of maintainers of MOS 2 that are needed to perform the maintenance action.

MOUBF - Mean Operational Units Between Failure. This is the number of operational units between failure, or more accurately stated the number of operational units between the need for this maintenance action. Depending on the “Type” for this subsystem the units could be rounds fired, distance traveled, or the amount of time that the system has been operating. The actual time when the need for this action will occur in the simulation will be drawn from an exponential distribution with a mean of this value.

MTTR - Mean Time To Repair. This value represents the average time it takes to perform this maintenance action. This value and the standard deviation for the repair time (SD MTTR) are used to generate a simulated time for this maintenance action from a normal distribution with a mean of MTTR and a standard deviation of SD MTTR.

Abort % - This value represents the percentage of time that the need for this maintenance action will cause the entire system to abort the current mission and have the maintenance done immediately.

CT - Contact Team. This cell contains an indication (yes/no) of whether this maintenance action could be performed by a contact team. This does not necessarily mean that a contact team will perform this maintenance action. It also depends on whether a contact team has been defined, whether it has been enabled for the current run and whether there are enough contact team maintainers to perform this action.

CC - Crew Chief. This cell contains an indication (yes/no) of whether the crew chief is qualified and equipped to perform this maintenance action. If the maintenance action is needed, and the simulation model predicts that any required spares are available, and the user has entered a "yes" in this column, then the maintenance task will performed by the crew.

As you can see, there are many more columns on the task spreadsheet than will fit into the workspace window. You can choose to display selected columns to customize the display for your needs. You select cells of the task spreadsheet by clicking on them. You can select a group of cells by pointing to a cell and holding down on the left mouse button while you drag the mouse to highlight the cells you want to select. To select an entire row or column, including cells not visible in the window, click on the row number or the column label.

Use the "Previous" and "Next" buttons to progress through the list of components.

Add Button

Clicking on the "Add" button allows you to select another repair action for this component.

Duplicate Button

Clicking on the "Duplicate" button will produce another repair action with all its data exactly like the repair action that is highlighted in the spreadsheet.

Delete Button

Clicking on the "Delete" button will delete the highlighted repair action in the spreadsheet.

Scenarios

This interface, shown in Figure 3-23, contains the list of scenarios available for your maintenance analysis. In order to view more information about a scenario, highlight it and press the "Open" button. This will let you edit and review the scenario parameters.

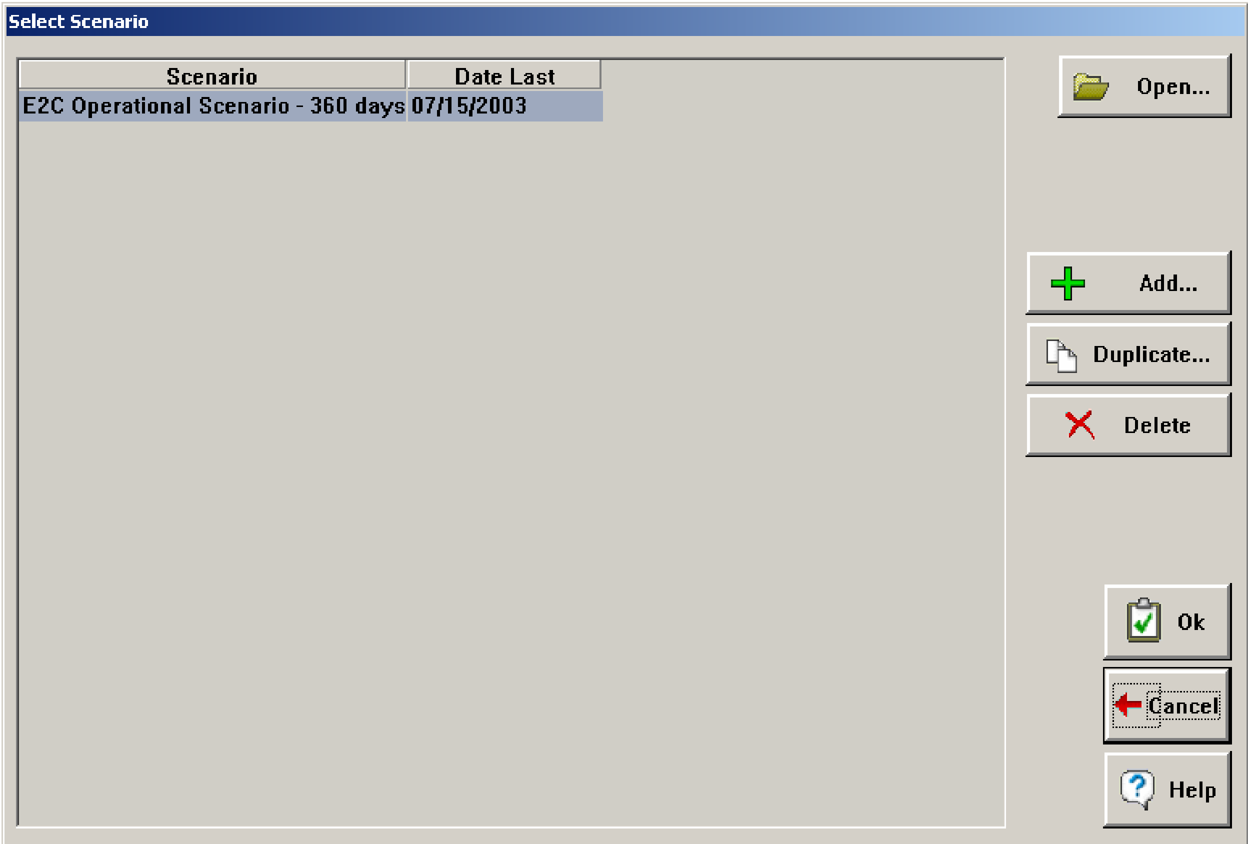


Figure 3-23. Select Scenario

You can develop many scenario data sets for each system. For example, you might want to create one scenario for a thirty day run and another scenario that contains input parameters for a ten day run. When you have selected a scenario, this option also lets you add mission segment data for that scenario.

You can add, duplicate, and delete scenarios.

Open Scenario Button

Click on this button to open the scenario whose name is highlighted in the scenario spreadsheet. You can then review or edit data from that scenario.

Add Button

Clicking on the “Add” button allows you to type in the name of an additional scenario.

Duplicate Button

Click on the “Duplicate” button to add a new scenario that has a data set exactly like the scenario that is highlighted in the spreadsheet. You should give the replicated scenario a name that is different than the original scenario.

Delete Button

Click on the “Delete” button to delete the highlighted scenario in the spreadsheet. It will also delete all information associated with that scenario, such as segment data.

Scenario Parameters

The screen shown in Figure 3-24 contains information on the scenario you selected. You can enter a textual description of the scenario. In addition, you can use the buttons on this dialog to access several different kinds of information attached to a maintenance scenario.

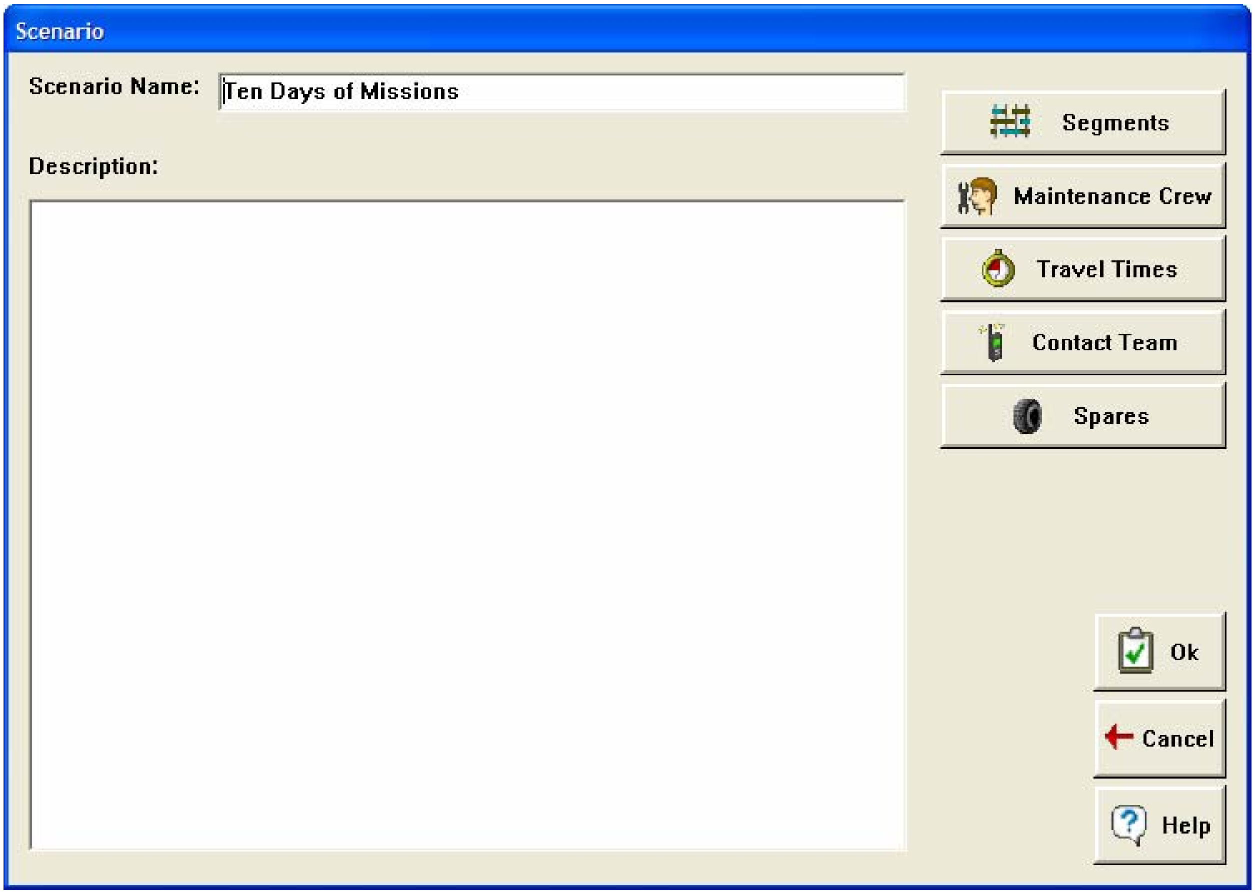


Figure 3-24. Scenarios

Segments Button

Use this button to decompose your scenario into individual mission segments.

Maintenance Crew Button

Click on this button to describe or review data on the maintenance concept. The maintenance concept consists of things such as the number of maintenance levels, the numbers of shifts, the manning levels, and contact team utilization.

Travel Times Button

Click on this button to describe or review the delay times expected when moving the system from one level of maintenance to the next (e.g., from Direct Support to General Support).

Contact Team Button

Click on this button to describe or review the contact teams. This represents the maximum number of systems that will be waiting for service from the contacts team. Once this maximum is reached, systems needing service will be routed to the traditional maintenance originals.

Spares Button

Click on this button to describe or review the expected availability of spare parts needed for repairs and the delay times associated with obtaining spare parts. You can specify spare data at the subsystem level.

<u>Segments</u>

Each scenario is composed of a set of mission segments, as illustrated in Figure 3-25. These segments can be thought of as missions, in which a number of your systems are exercised. During a segment, the components accrue usage, which can lead to component failure. You can enter the parameters that are attached to a segment by pressing the “Operational Profile” button. (Do not confuse these missions with the operational missions described under the “Define System Mission” portion of IMPRINT. While they are similar concepts, none of the data you entered under “Define System Mission” will affect the results of your “Define Equipment” analysis.)

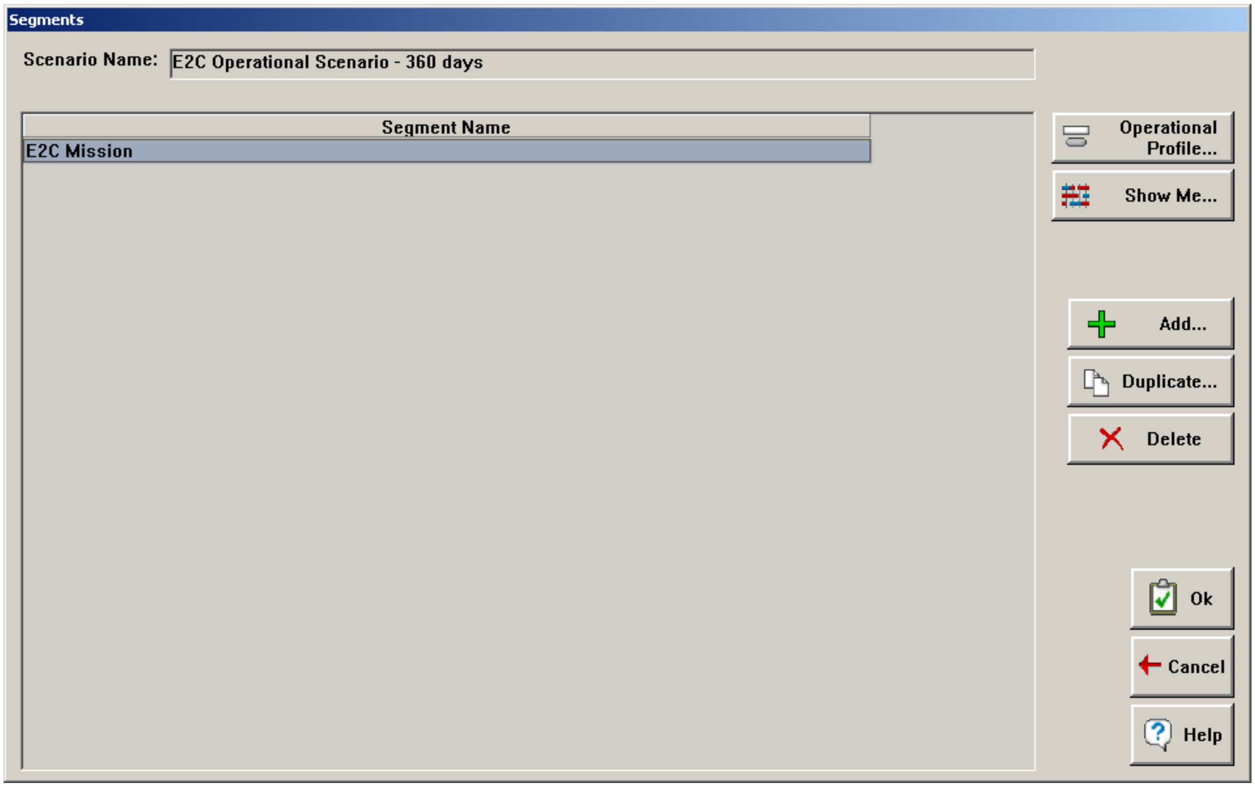


Figure 3-25. Segments

To view a graphical schedule of your segments, press the "Show Me" button. You will see a Gantt-Chart style screen from which you can add new segments, delete existing segments, or adjust the schedules and durations of existing segments.

Add Button

Click on the "Add" button to type in the name of an additional segment. In order for the additional segment to impact the maintenance model, you must also provide segment data.

Duplicate Button

Click on the "Duplicate" button to produce another segment with all its data exactly like the segment that is highlighted in the spreadsheet. You should give the replicated segment a name that is different from the original segment.

Delete Button

Click on the "Delete" button to delete the highlighted segment in the spreadsheet. It will also delete all information associated with that segment, such as departure data.

Operational Profile Button

Click on this button to describe or review the operational profile of the segment you have highlighted. The operational profile contains segment data such as the start and stop times, times between departure, and number of systems needed.

Show Me Button

Click on this button to view the operational profile of the segment you have highlighted in a Gantt-like form. Most of the same data and editing functions that are available when you click the "Operational Profile" button are also available here.

Operational Profile

After you select a scenario and enter scenario parameters, IMPRINT presents an Operational Profile window on which you specify characteristics of the segments, as shown in Figure 3-26. You can define several segments for each scenario. For example, if you are modeling a large number of systems, you may want to define different missions for smaller subsets of your total number of systems. To develop a description of the segments that make up your mission, click on the Segments button from the Scenario dialog box. When you make this selection, IMPRINT will display a list of the segments currently in the scenario you selected.

The name of the Scenario you have selected and the Segment Name are displayed near the top of the dialog box. Below the Segment Name is a box in which you may type in a description of the currently selected segment. Below "Segment Description" are fields you may fill in to define parameters that will describe the operation of this segment. First are the Segment Start Time and Segment Start Day. Next is the Cancellation Time. These time values default to 00:00:00.00. The Duration Time and Priority follow this. You also must select the Minimum and Maximum Number of Systems Needed, the Number per Departure Group, and the Time Between Departures in minutes. If you want this segment to repeat, select the check box next to Repeating and enter the Repeat Mean Time and the Standard Deviation.

This dialog box also includes buttons along the right edge of the dialog box for further defining this segment. Select the "Combat..." button to enter the combat damage parameters for this segment. Select the "Consumables..." button to describe the number of miles traveled and rounds fired by the equipment during this segment.

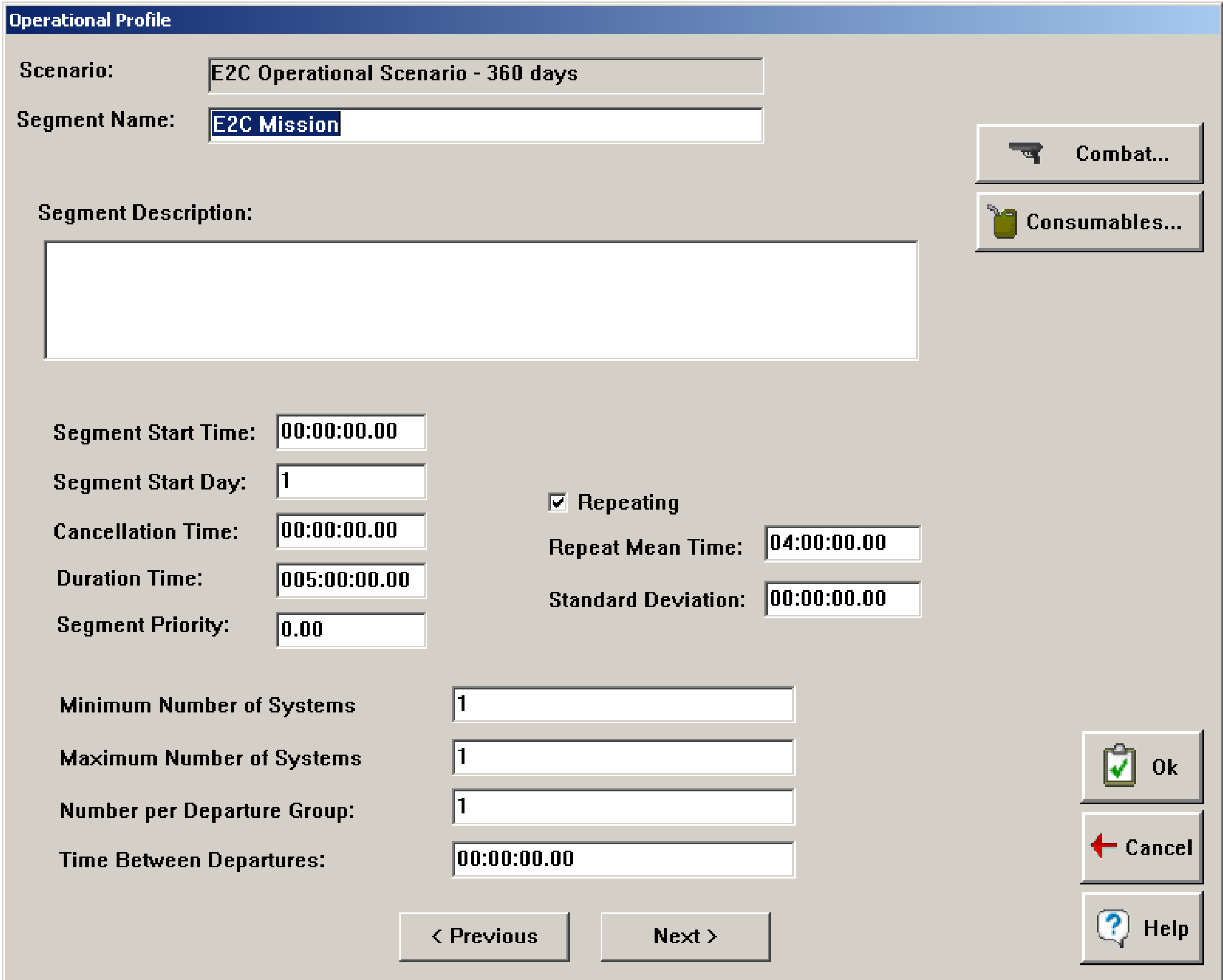


Figure 3-26. Operational Profile

At the bottom of the screen are buttons for going to the “Previous” and “Next” segments.

Combat Button

This button provides access to a dialog that lets you specify the probability and severity of combat damage likely to be encountered on this segment.

Consumables Button

This button provides access to a dialog that lets you specify the number of rounds fired by each weapon subsystem of your system for each hour of this segment. It also lets you access the distance traveled, and any load time required for the segment.

Show Me

Another way to develop or edit the descriptions of the segments making up your mission is to click on the “Show Me” button from the Segments dialog box. When you make this selection, IMPRINT presents you with a window containing a Gantt-like chart, as shown in Figure 3-27. The name of the scenario you have selected is displayed at the top of the dialog box. Below the scenario name is a tool bar that you may use to define parameters that will describe the operations of each segment in the scenario. Below the tool bar is a chart containing each Segment (represented as a bar) in the scenario.

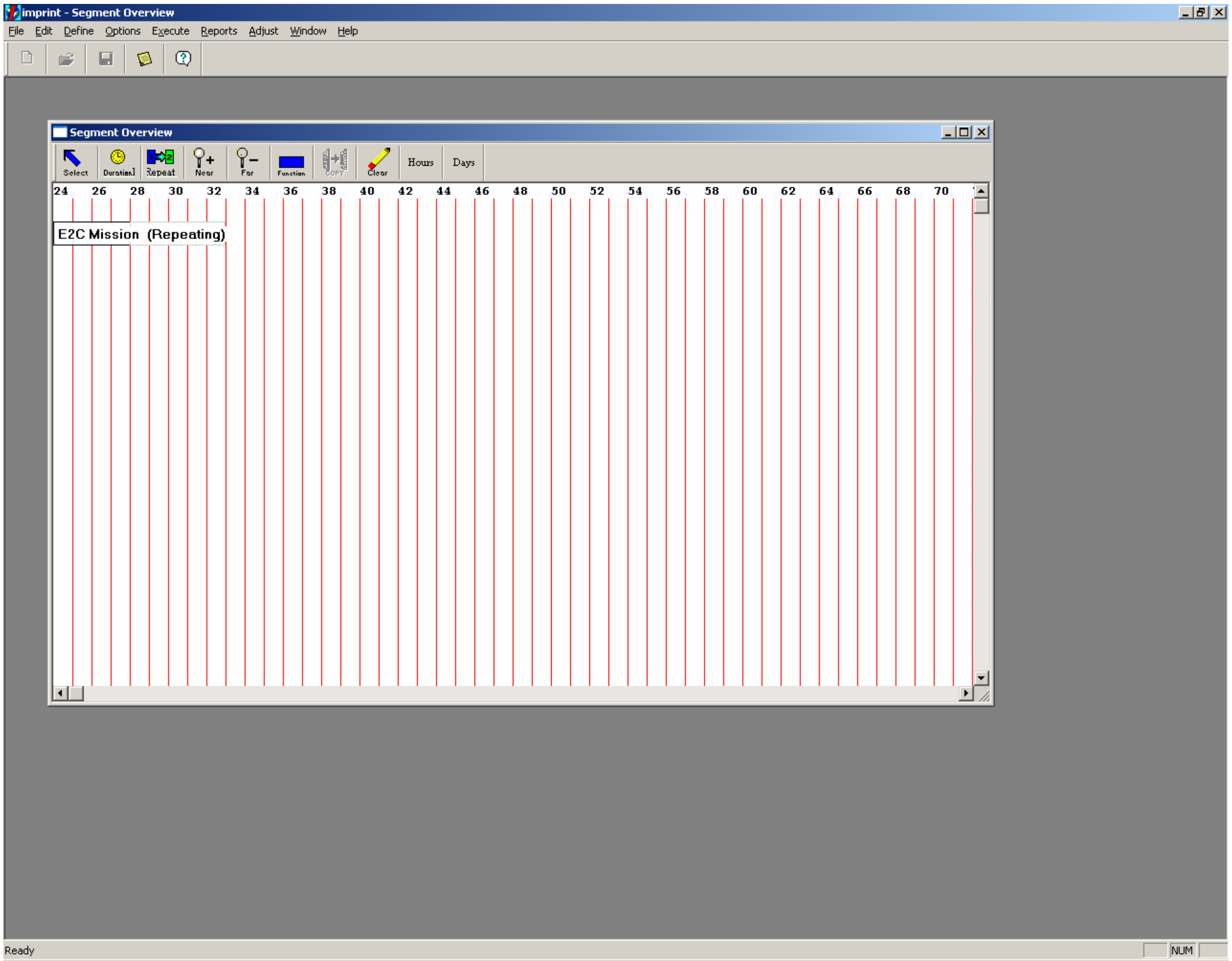


Figure 3-27. Operational Profile from a Different View

The “Select” tool allows you to select a particular segment on the chart. Click once on the bar representing the segment you would like to edit. Then you can move the segment horizontally using your mouse to change the hour/day in which you would like the segment to begin. If you double-click on a segment, IMPRINT will present you with the Operational Profile window for that segment.

The “Duration” tool allows you to change the duration of a segment by adjusting the bar length of a particular segment. To use the “Duration” tool, click in the segment bar that you want to change, and then drag the right edge of the bar to the length that you desire. If you want a segment to repeat, click once on the “Repeat” tool and then click once on the segment you would like to repeat. Text will appear on the bar of the segment you have chosen to inform you that the segment is repeating.

The “Near” and “Far” tools allow you to see the layout of the scenario from different viewpoints.

The “Segment” tool allows you to add a new segment to the scenario and the “Copy” tool allows you to copy an existing segment.

The “Clear” tool allows you to delete individual segments one at a time from the scenario.

Finally, the “Hours” and “Days” buttons allow you to set whether the chart displays the timeline in either hours or days. Once you close this window, all of the changes you have made will be applied.

Combat

The dialog shown in Figure 3-28 enables you to view and modify the combat damage parameters for this segment. Combat parameters include the following:

- the hourly probability that a system will sustain a combat hit
- given a combat hit, the probability that the system is a total loss
- if the system is killed, the number of hours before the system can be replaced
- given a combat hit, the probability that the system can be repaired
- if the system can be repaired, the amount of time needed to complete the repairs

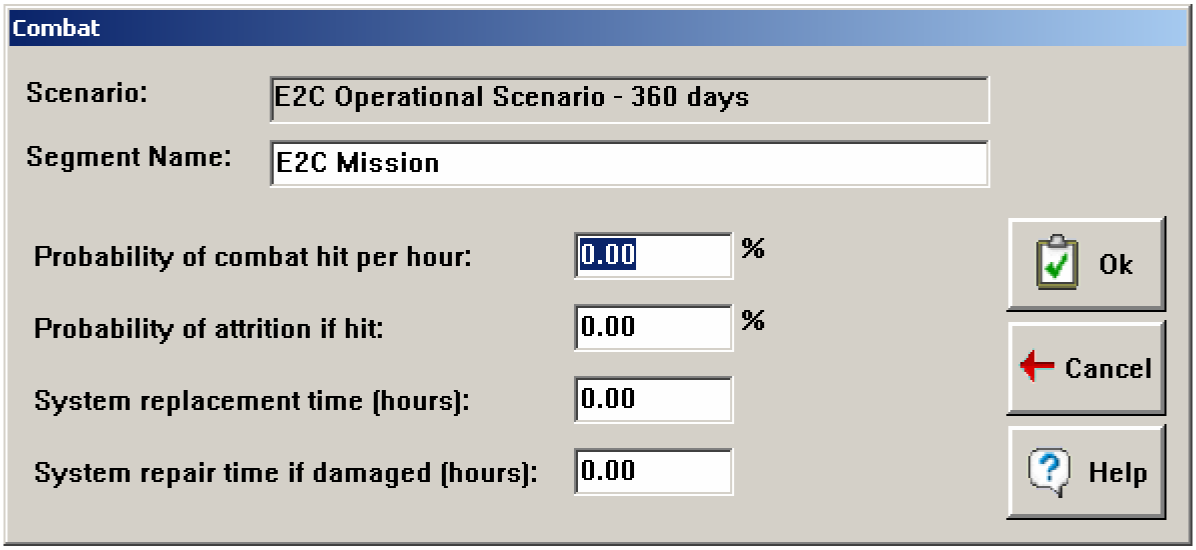


Figure 3-28. Combat

The repair time will impact system availability, however it is not included in the maintenance man-hour requirements reports. This is because IMPRINT doesn’t know which component(s) need repair due to combat damage, and therefore, doesn’t know which MOS would be needed. Consequently, all time spent performing combat damage repair is reported in the Combat Damage report, and is not attributed to any particular MOS.

Consumables

For each of the subsystems that were defined on the task spreadsheet there is an assigned "Type" of Armament, Distance, or Other. For each Armament subsystem, you need to specify the number of rounds of ammunition that will be fired from the weapon that contains that subsystem during this segment. You do that on the dialog shown in Figure 3-29.

Additionally, on this dialog, you can enter the distance your system will travel during each hour of the segment and any preparation, or load time, which is needed before the segment begins. The load time will not require man hours, but could affect system availability. You can also enter the amount of fuel used by the system in gallons per distance unit. This value is used to help IMPRINT calculate the Supply and Support requirements of each scenario.

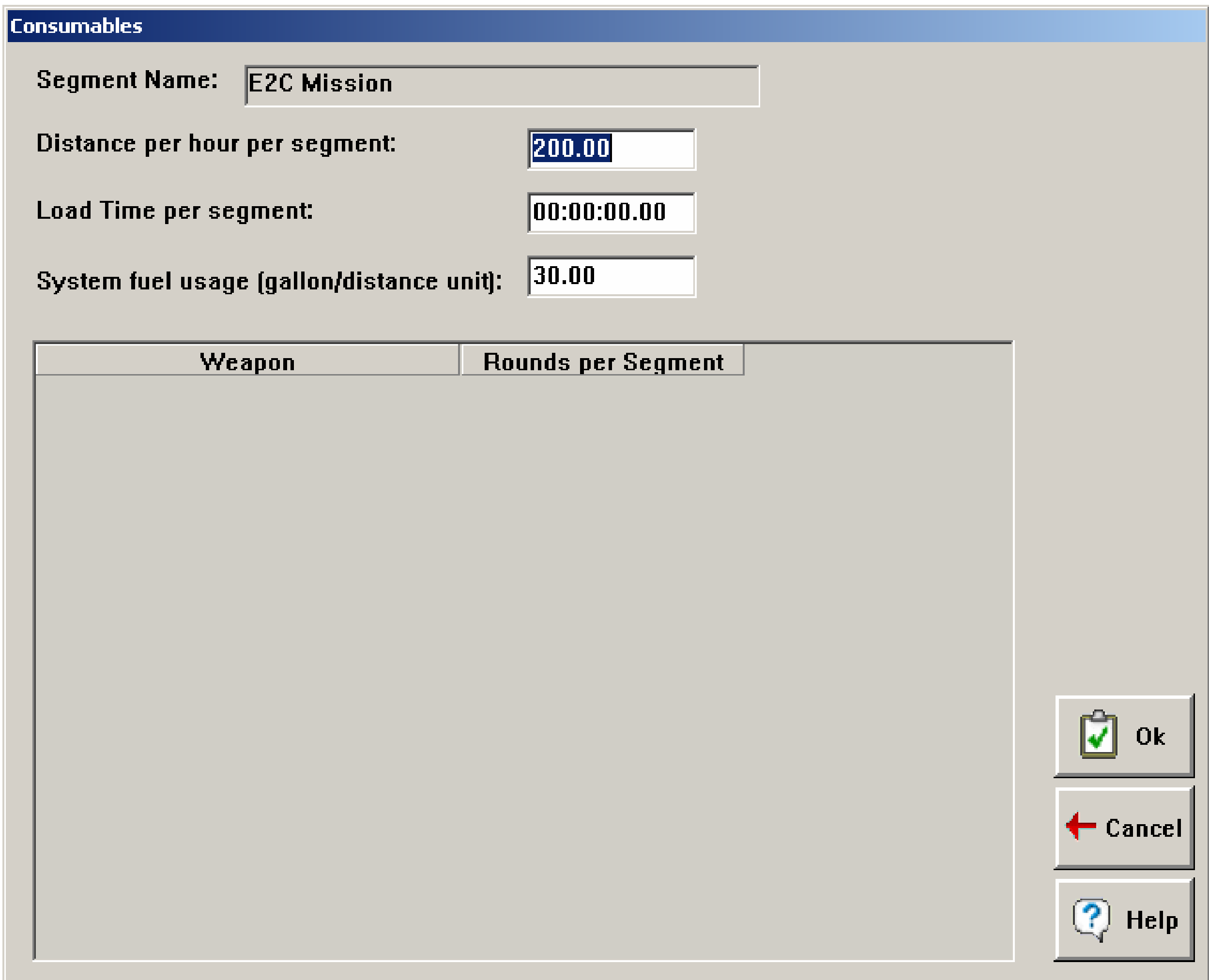


Figure 3-29. Consumables

The distance traveled and rounds fired are used to accrue usage to the components of systems as they perform the segments. Ultimately, this will cause components to fail, based on the Mean Operational Units Between Failure of each component.

Maintenance Crew

This option lets you define the shift manning for each specialty performing tasks at each maintenance level type (e.g., Unit, Direct Support, General Support). You can also identify shift manning for more than one shift. If you have edited the names of the different maintenance levels, your new labels will replace the ones shown in Figure 3-30.

To set the shift manning, you use a spreadsheet that contains the number of people within each specialty for each maintenance shift that can work in parallel throughout your scenario. When you click one of the maintenance organizational type buttons, IMPRINT displays the spreadsheet for that level.

The numbers of hours in a shift and shifts in a day are shown at the top of the dialog.

There is a check box available on the Execute Maintenance Model screen that lets you run the scenario in an unconstrained mode, regardless of the entries you make on this dialog. This means that IMPRINT will ignore the shift manning in this spreadsheet. In other words, any time a maintainer is needed to perform a maintenance action, that maintainer is assumed available. Essentially, this means that an unlimited number of maintenance tasks can be performed in parallel.

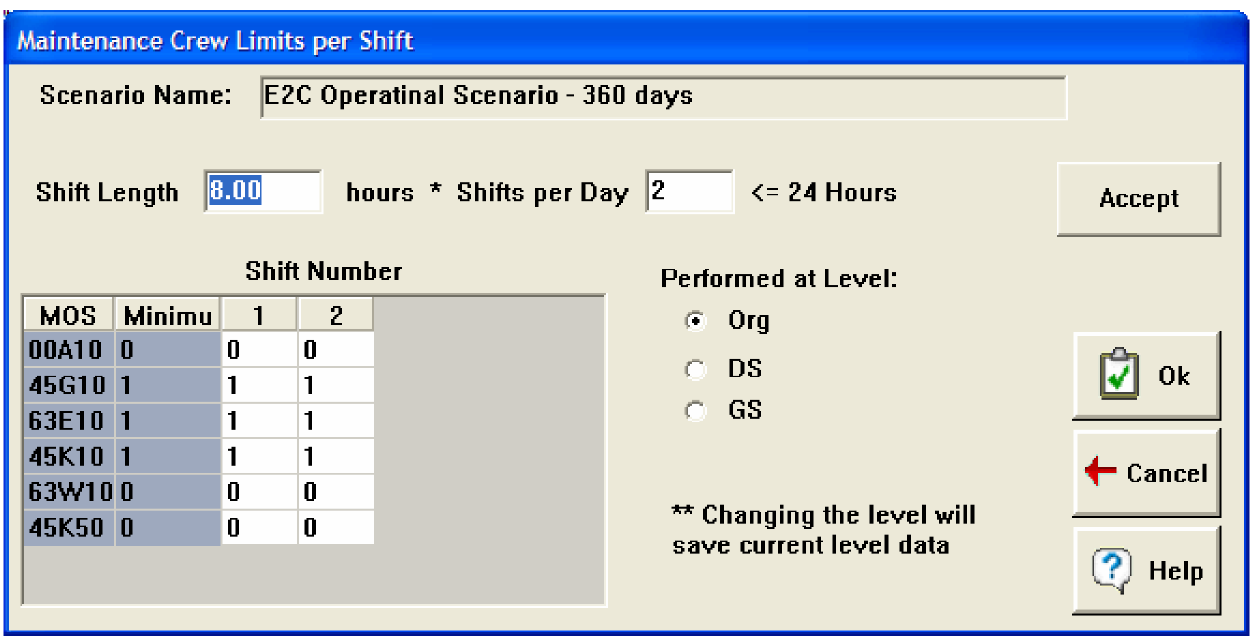


Figure 3-30. Maintenance Crew Limits per Shift

In the spreadsheet itself, you will see a column for each shift. As with all spreadsheets in IMPRINT, click in a cell of the spreadsheet to edit the contents of the cell. Select an entire row or column by clicking the row number or column name.

The column titled "Minimums" identifies the minimum number you can enter for your manning of each MOS at each organizational level. This minimum is calculated by examining your repair tasks to find the maximum number of people in a given MOS needed on a single repair task. This ensures that your crew will be able to perform every task that could occur.

In order to evaluate which MOS' are the most heavily utilized, we recommend you refer to the Headcount Histogram Report. This is discussed in detail under the Reports portion of this User's Guide.

Travel Times

This option lets you enter the average number of hours it takes to travel from where the system breaks down to the maintenance locations. You do this on the dialog shown in Figure 3-31. These maintenance locations will be labeled as shown above, unless you edit the level names, as discussed in the "Options" portion of this User's Guide.

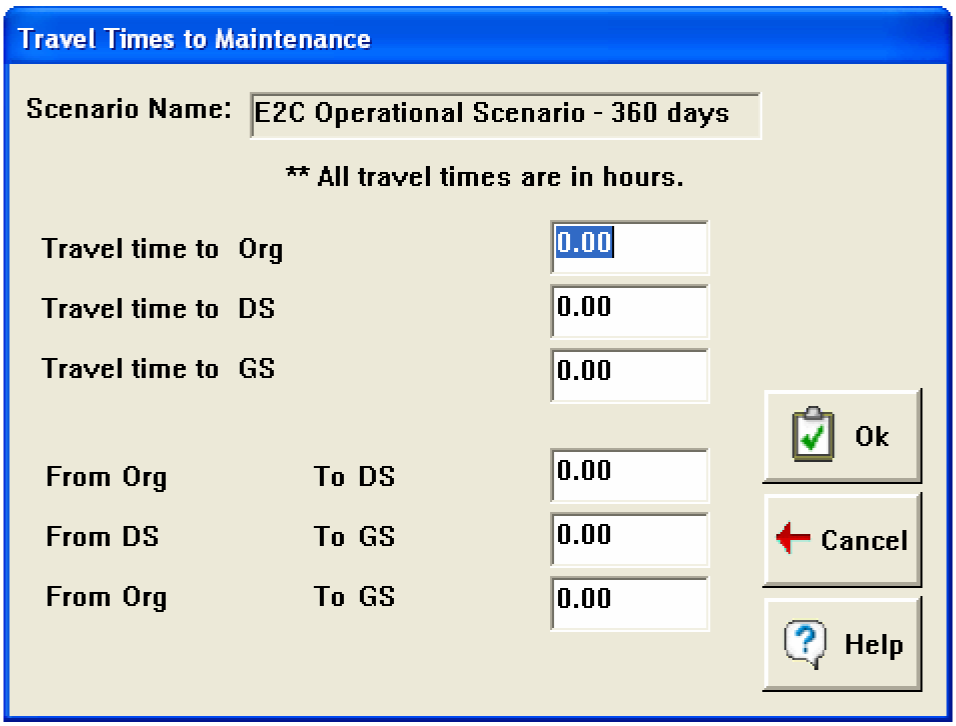


Figure 3-31. Travel Times to Maintenance

The travel time you enter, in hours, represents round trip travel. This time is added to the maintenance time for a system to accurately reflect system availability. It does not affect maintenance man-hours. It only affects the total time to repair the system.

Enter the travel times to move the system to and between the different maintenance levels. These travel delay times will be used to predict how long it will take to transport the system, or the component, to the appropriate organizational level. Note that in the maintenance model, all first level (e.g., ORG level) maintenance is performed first, then second level (e.g., DS), then third level (e.g., GS). The travel time is a one-time assessment for each system each time it completes a mission segment and needs maintenance.

Contact Team

This option lets you enter the following: Number of Contact Teams, Number of maintainers in each Contact Team and Maximum number of repair that can be waiting for the attention of each of the above contact teams.

If the contact team is enabled then the maintenance action is routed to the contact teams as long as the following parameters are met:

- The number of maintenance tasks waiting in the queue is less than the total number of tasks all the contact teams combined are capable of handling.
- The number of maintainers needed to perform the maintenance is less than the number of maintainers on the contact team.

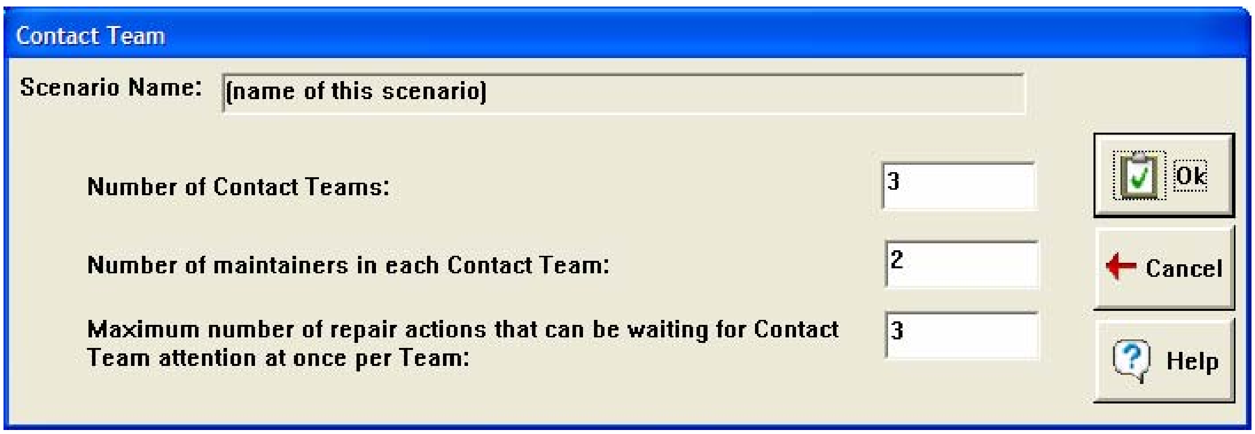


Figure 3-32. Contact Team

Spares

Use the spreadsheet shown in Figure 3-33 to specify (by subsystem) the percent of time a spare part will be available when needed for a repair action and, if not available, the delay time until it will be available.

This optional capability lets you enter the probability of available spare parts when they are needed for maintenance. You can enter a different probability for each subsystem in the IMPRINT maintenance task spreadsheet. You can also enter the average wait time (in hours) for parts that are not available.

Spare availability only affects Remove and Replace tasks being performed at the first (e.g., Unit, Org, or AVUM) level of maintenance.

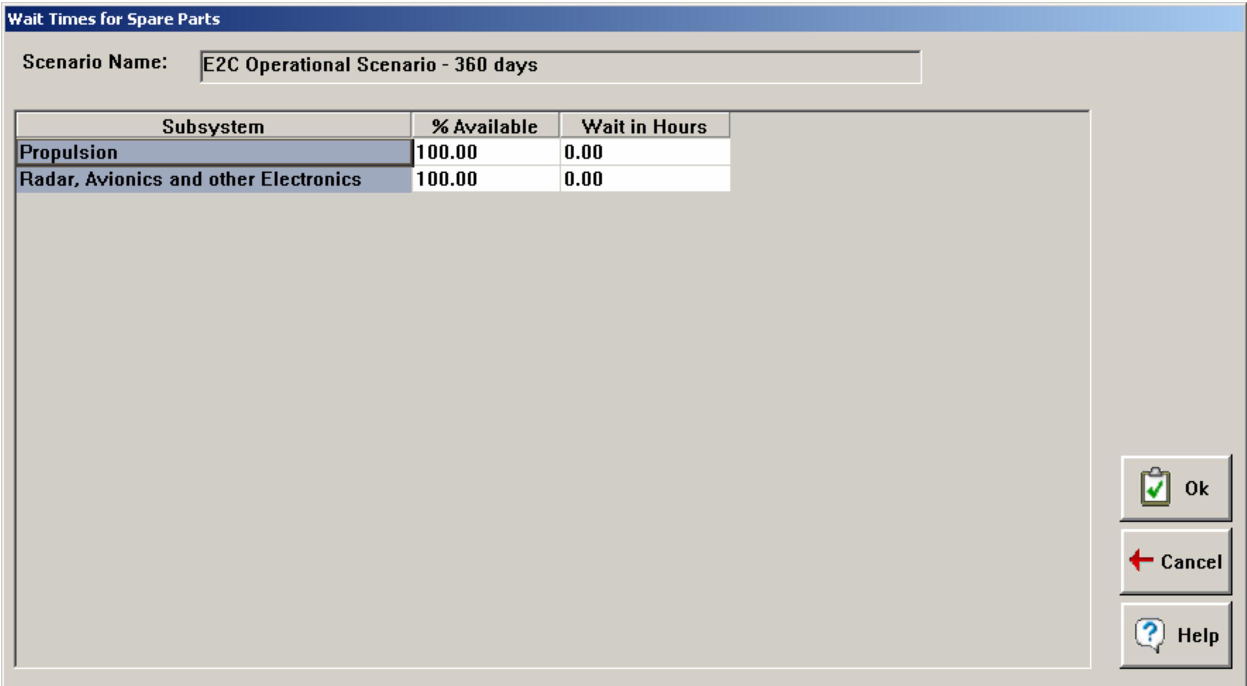


Figure 3-33. Wait Times for Spare Parts

Soldiers

The objective of the Define Soldiers module is to help you estimate the type of people that will be available to operate and maintain the system for the manpower, personnel and training (MPT) analysis.

This module lets you select MOS' that are likely to be available, probably from a predecessor system to operate and maintain the new system. It then permits you to "project" MOS' into the future, as well as see when the new system will be fielded, and obtain estimates on their personnel characteristics.

A personnel flow model is used to make projections of what the selected Military Occupational Specialties (MOS') are likely to look like in the future. The projections are based on historical trend data contained in the IMPRINT library. Also within this module is an option that allows you to change the historical trend data to reflect more recent personnel policies.

Since the system being supported by this analysis will not be fielded until sometime in the future, it is important that the personnel characteristics, and thus the performance of the operators and maintainers be related to that time frame rather than the present.

To begin developing estimates of future personnel characteristics, choose the "Soldiers..." option from the "Define" menu. You will then see a dialog like the one shown in Figure 3-34.

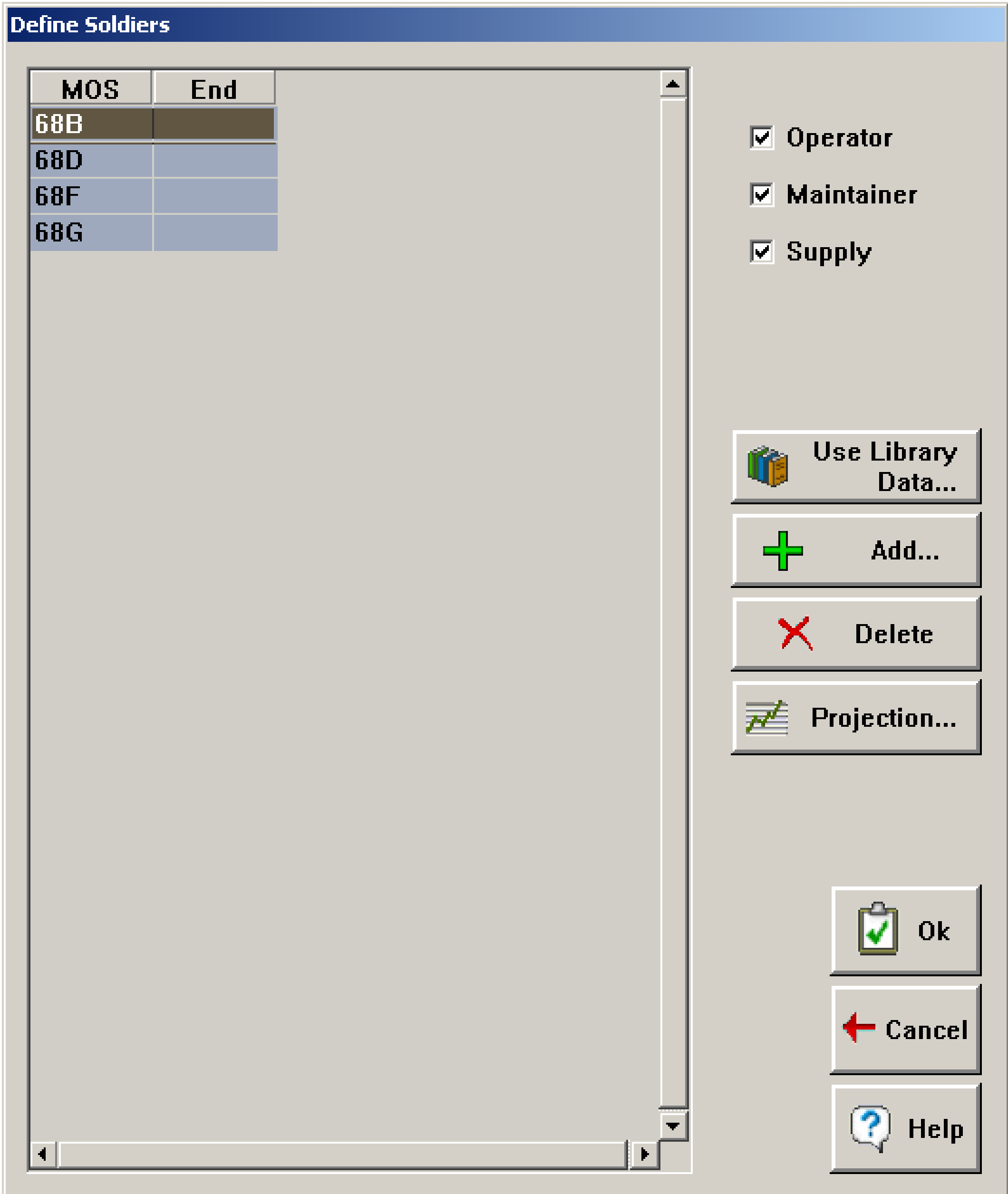


Figure 3-34. Define Soldiers

Adding or Removing an MOS

MOS’ can be added or deleted from the list of MOS’ available for the new system by clicking on the “Add” or “Delete” buttons on the “Define Soldiers” dialog box. To add an MOS click on the “Add” button. This will bring up an MOS Directory containing an ordered list of MOS’. The leftmost column gives the 3-digit code or designation for the MOS. As you move from MOS to MOS within the directory, the title of the MOS is displayed above the directory. Three "dummy" MOS’ have been included in the directory (i.e., XXX, YYY, ZZZ). You can use these MOS’ to represent new MOS’ or civilians in your analysis.

You will notice checkboxes for Operator, Maintainer, and Supply on this dialog. For each MOS, you place checkmarks in the boxes to indicate the role(s) that this soldier will play in the system. Then IMPRINT will make sure that this MOS is listed when you are selecting an MOS to perform an operational, maintenance or support task.

To delete an MOS, highlight or select the MOS and then click on the “Delete” button. It will be deleted from your analysis, but will still be available to other analyses through the library data.

Use Library Data Button

Click on this button to get a list of all library systems for which data (operator and maintainer MOS’) exist. When you select a library system from this list, all operator and maintainer MOS’ for that system will be added to the MOS spreadsheet.

Projection Model

The primary purpose of the personnel projection model (flow model) is to capture and project trends for the types of people entering and leaving a MOS. This is important because different types of people (e.g., male vs. female or Mental Category I vs. Mental Category IV) have different capabilities and thus perform tasks at different levels of proficiency (assuming a fixed level of training). To estimate how well a MOS can perform tasks associated with a new system sometime in the future, we need to have a general knowledge of what types of people will be in that MOS in future years.

The personnel projection model should <u>not</u> be used to estimate the precise numbers of people in each grade within an MOS. This is because personnel policies made at HQDA control the number of people, by grade, in a MOS, largely. These policies, such as promotion rates, are constantly reviewed and revised to keep the MOS at desired levels. Budgetary considerations are also crucial in determining strength levels within a MOS. The personnel projection model does not attempt to model either changing personnel policies or changes in manpower budgets.

Typically, you should run the projection model without changing the model parameters. If you elect to run the model without changing parameters, the flow model uses transition rates (i.e., a 0.5 promotion rate listed under E-4 indicates that 50% of the E-3s were promoted to E-4 that particular year) that are computed from historical data. It also uses Army endstrengths from the Program Objective Memorandum (POM) and projected accessions from an Army Research Institute (ARI) Propensity to Enlist study.

In IMPRINT, the flow model is constrained by trying to reach the target number of people for each projection year. In other words, the model tries to fill the MOS with high-quality people first, and then in order to meet the target number, fills it with progressively lower quality people. Often, this causes the MOS to have a lower average quality in the projected years.

Note: Running the flow model takes time. If you analyze numerous MOS’ over numerous years, IMPRINT will take a few minutes to complete the analysis.

Projection Model Parameters

The personnel projection model uses historical data (normally Enlisted Master File (EMF) data from the past year) to estimate the rates at which different types of people move in and out of a MOS. There are advantages and disadvantages of using the past year's data to estimate trends and make projections based on them. The major advantage is that the data are current and reflect recent trends. The disadvantage is that abnormal behavior or radical restructuring of the MOS can be captured as trends and projections may be unrealistic. The personnel flow model employs a modified Markov Chain algorithm to apply accession, continuation, promotion, and migration probabilities to determine projected inventories.

Please note that the personnel data in IMPRINT are as of a certain date (e.g., the end of FY97 or 31 September 1997). IMPRINT is updated periodically with personnel data from Personnel Command (PERSCOM) databases. The personnel transition rate data for IMPRINT Version 5.0 are from FY97 records. The personnel inventory data are as of 31 September 1997. The accuracy with which IMPRINT will describe MOS' is obviously dependent on when the data were last updated. Also, there are constant changes in the Enlisted Personnel Classification System whereby MOS' are deleted, created, and consolidated. IMPRINT personnel data may or may not reflect these changes, depending on when the data where last updated. The personnel projection model will only project 20 years into the future.

The model operates at the MOS, grade, year of service, quality and demographic level of detail. It begins with the current inventory from the Army's EMF. It also uses the EMF to calculate historical transition rates (e.g., separations, promotions, migrations, etc.) for each subpopulation in an MOS. Subpopulations are defined by gender, high school graduate status, and test score category. The model also uses historical accession data from the EMF, Army end strength projections from the Army Program Objective Memorandum (POM), and estimated available accessions from an ARI propensity to enlist study. All these data are contained in IMPRINT libraries and provided automatically to users. You can change these data by using the buttons on the dialog shown in Figure 3-35.

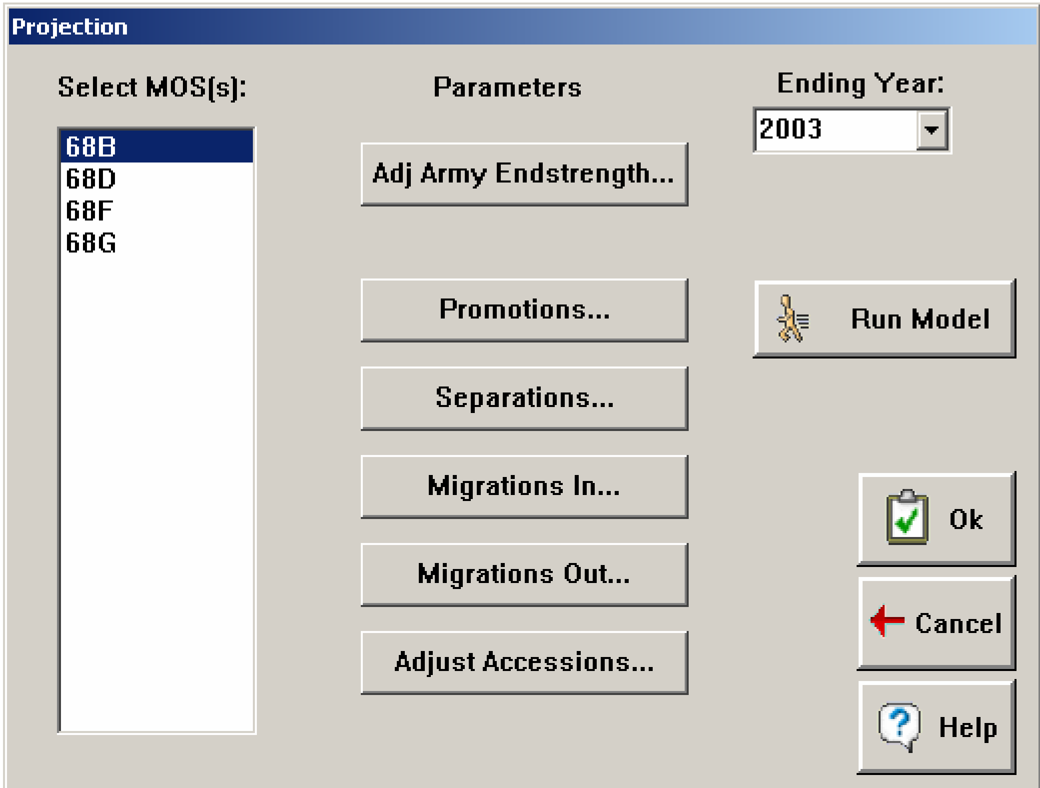


Figure 3-35. Projection

An example of an unrealistic projection could occur in the following manner. Say MOS XXX has grown rapidly during the past year in order to provide enough operators for a new vehicle being fielded. This growth could have occurred by obtaining E-4s and E-5s from other MOS'. (This would cause MOS XXX to have a large migration-in rate for those grades). If these same migration-in rates are used to project for future years, the E-4 and E-5 populations within the MOS will become unrealistically large - so large, in fact, that the MOS will try to maintain its overall strength by limiting the number of accessions that are allowed to come into the MOS. This, in turn, will cause the E1-3 grade to become unrealistically small. MOS XXX will then show a tremendous grade imbalance that would never have been allowed to occur.

When reviewing results from the personnel projection model, you should be aware that anomalies like the one described above could occur. You have two options when these anomalies occur. First, you can proceed with the analysis with the assumption that, although the grade structure within the MOS is misaligned, the changes in types of people within the MOS have been captured and are suitable for further analysis. The second, and more complicated option is to determine the cause of the anomaly by reviewing the transition rates (migrations, promotions, etc.) that were used in projecting the MOS. Having discovered an unusually low or high transition rate, you can then change it to reflect a more stable and realistic rate. Realistic rates can be obtained from other MOS' known to be relatively "stable" during the last year.

Force Structure

Define Force Structure helps you develop Army-wide estimates for manpower required to operate, maintain, and support a weapon system. Although Define Force Structure can be used in a “stand alone” mode (i.e., without running through Define Mission, Define Equipment, or Define Soldiers first), the most common case will be to use it last after conducting the other analyses.

Initially, you identify the types and quantities of units in the Army Force Structure for which manpower requirements will be computed. These will be the units in which the new system is scheduled to be fielded. You do this using the dialog shown in Figure 3-36.

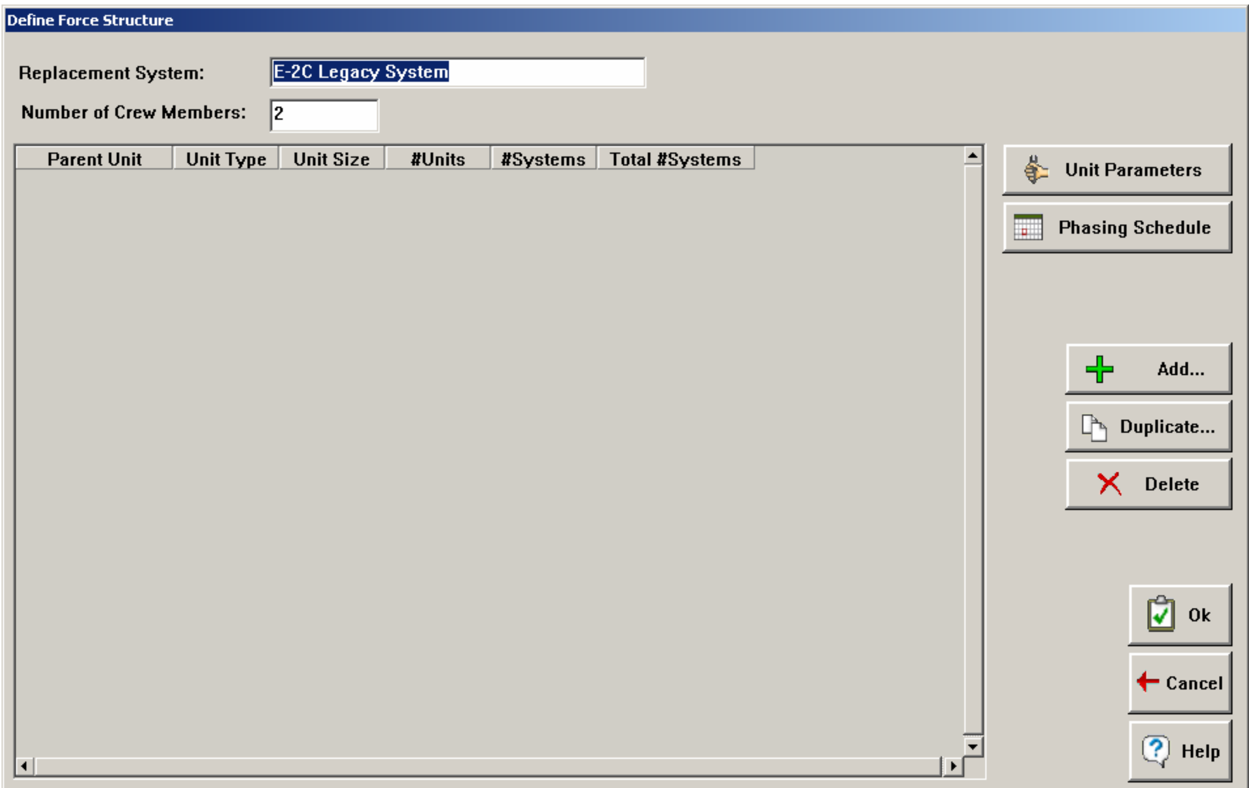


Figure 3-36. Define Force Structure

If you do not know what units to include in the Force Structure, you have the option of including all units that have the type of weapon system for which the analysis is being conducted. Define Force will automatically provide a list of all units that have the type of weapon for which the analysis is being conducted. You can then edit this list. The result is a list of active Army Tables of Operations and Equipment (TOE) units, by type and number, with the number of systems to be fielded, by year, for each type of unit.

In Define Mission, you specify the crew members (and therefore crew size) for each weapon system. Define Force uses the specified crew size as a basis for estimating Army-wide requirement for operators of the new system. The number of required operators is a function of the types and numbers of units receiving the new system, the number of new systems being fielded, and the crew ratio. If you did not conduct a Define Mission analysis, you can enter the operator requirement from scratch.

Normally, you will have run a maintenance simulation in Define Equipment using a representative unit (or “pacing” unit) in which the new system will be fielded. Pacing units can be thought of as major building blocks within Divisions and Corps. In many cases pacing units will be battalions. For example, when modeling weapon systems in Infantry and Armor units, it is recommended that a battalion be modeled. In another case, if modeling a new system for a chemical unit, it is recommended that a company be modeled. The idea is to determine manpower requirements for the pacing unit, via modeling, and then multiply those manpower requirements by the number of those units in the Army, to get Army-wide manpower requirements.

The maintenance manpower requirements for the simulated unit (i.e., pacing unit) will be used in Define Force to compute manpower requirements for other units in which the new system will be fielded. The data from Define Equipment provide the basis for estimating Army-wide manpower requirements for all other types and sizes of units. Default values are provided for those units not modeled in Define Equipment.

This does not mean that you cannot change the Define Equipment numbers once they are brought into Define Force. You will have the option to edit them in Define Force. You can change the Define Equipment data by choosing to edit maintenance man-hours (MMH). The number of required maintainers is a function of the number and type of units, number of systems to be fielded, system reliability, maintenance ratio, operating tempo, and battle damage. If you did not conduct a Define Equipment analysis, you can enter these numbers from scratch.

Unit Parameters Button

Use this option to change the parameters of the units to which the new system will be assigned. You can change the operating tempo (OP Tempo), the maintenance man-hours, and the crew ratio.

Phasing Schedule Button

Use this button to indicate to IMPRINT when each unit in the force structure will be getting the new system. You can also set the replacement ratio for when the new system will replace the current system.

Unit Parameters

Since the data from Define Equipment, if available, are used to estimate Army-wide manpower requirements for all other types and sizes of units, IMPRINT asks you to select an existing maintenance scenario from which the Unit Parameter values can be established, as shown in Figure 3-37. Alternatively, you can choose to bypass this option, and set the values from scratch.

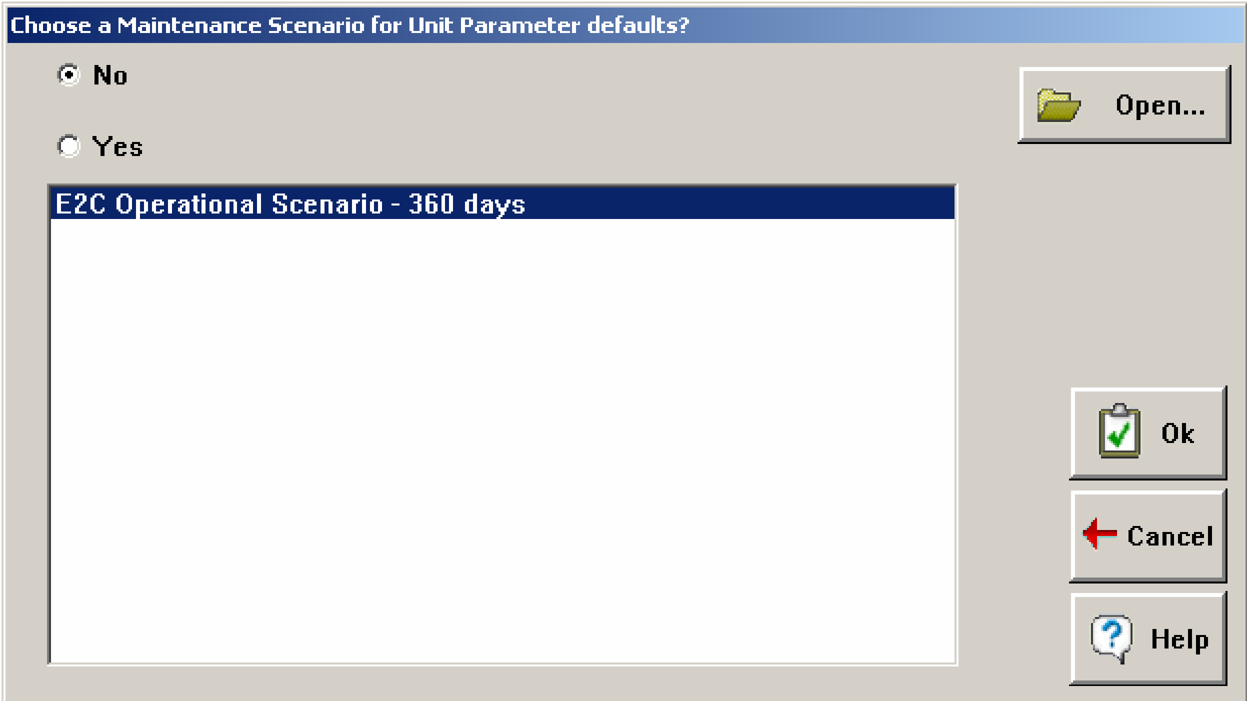


Figure 3-37. Select a Scenario

Make a selection on this screen, and click on the “Open” button to progress.

You use the screen shown in Figure 3-38 to edit the operating tempo, maintenance man-hours (MMH) needed at each maintenance organizational level, the annual MMH available per year, and the crew ratio for your new system in the identified unit. If you have executed a maintenance model, the values in the MMH/System text boxes will default to the values calculated by the model for appropriate units.

The Annual OP Tempo is the usage per year that the new system is expected to accrue in the type and size unit listed. The OP Tempo is associated with a unit of measurement (e.g., flight hours, miles driven, etc.). The Annual MMHs/system (ORG, DS, & GS levels) are the total number of annual maintenance man-hours (by maintenance level) required to maintain the systems in that unit. The Annual MMH available/year are the number of hours for each soldier at each org level that can be spent performing maintenance tasks. This value is used to calculate the number of maintainers needed to support the unit. Finally, the Crew Ratio is the average number of crews available for each new system in the unit. In some cases where systems are required to operate continuously there may be multiple crews for each system.

You can use the "Previous" and "Next" buttons to move through each of your units on this dialog.

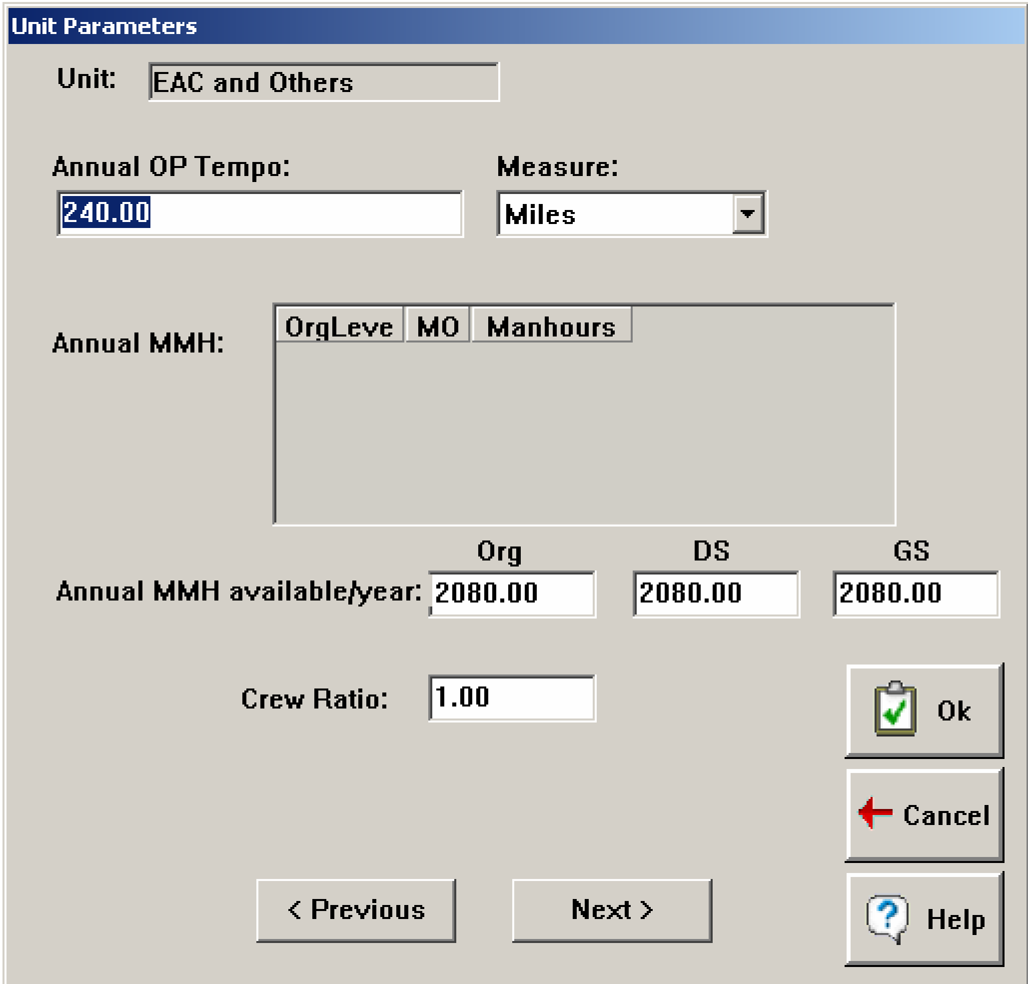


Figure 3-38. Unit Parameters

Note: If you edited the names of the maintenance organization levels, your new labels will be used on this dialog.

Phasing Schedule

You can use the screen shown in Figure 3-39 to tell IMPRINT how you want the new systems phased into your unit. The phasing will default to a 1:1 ratio of Replacement Systems to New Systems.

The "Replacement Systems" is the number of old systems that will be replaced in that unit. The "New Systems" is the number of new systems that will be fielded in that unit. You can use the drop-down box under "Year" to select the year in which the old replacement systems will be exchanged for new systems.

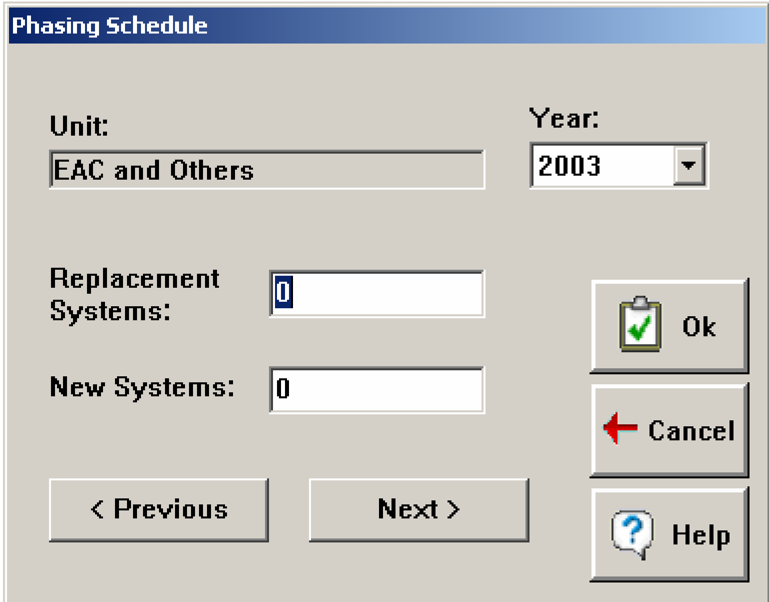


Figure 3-3920. Phasing Schedule

Supply

You can enter information on how the necessary fuel and ammunition will be supplied to your systems in each scenario under this IMPRINT option. This information, along with the data entered under Define Equipment, allows IMPRINT to calculate the number of transporters and the associated manpower that will be required to support each scenario.

Fuel

From the main menu item "Define" choose "Supply" and then "Fuel." You will then be presented with the dialog shown in Figure 3-40. First, you need to select the scenario for which you want to set the fuel supply parameters. Then, you need to enter the Transporter Name, the capacity of that transporter, the manpower required for the transporter, and the maximum number of trips the transporter makes in a single day.

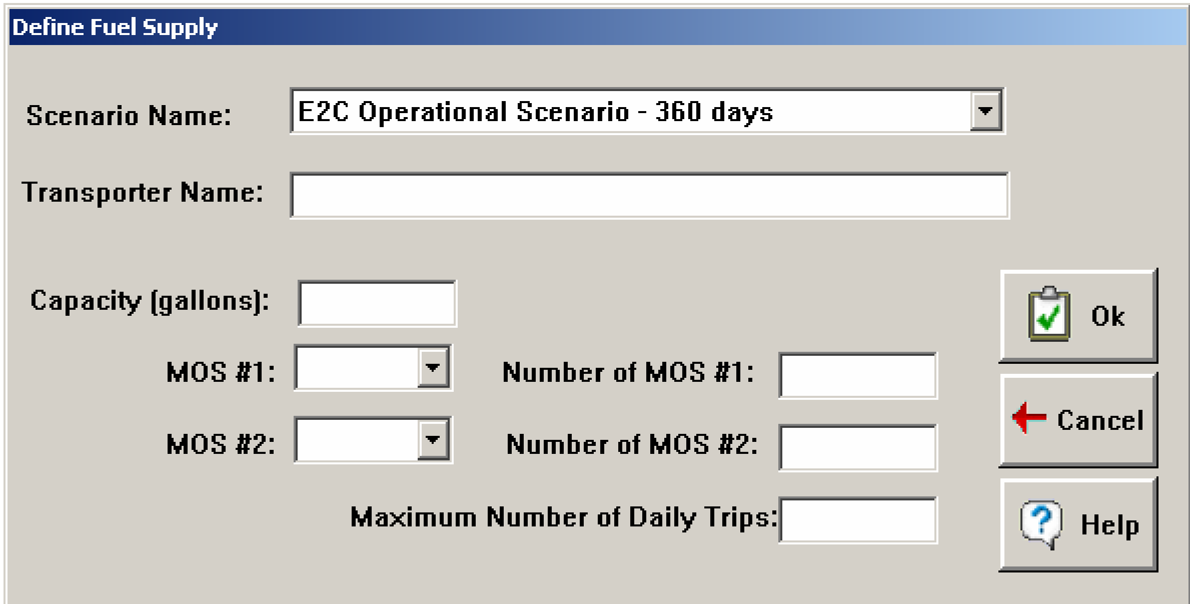


Figure 3-40. Define Fuel Supply

If the MOS you desire is not listed, you must return to the "Define Soldiers" menu item and add the MOS. It will then be displayed in the combo box.

IMPRINT will use this information to calculate the number of transporters and the associated manpower required to supply the necessary fuel for your scenario. After executing the maintenance model for this scenario, the supply results will be presented in the Supply and Support Results.

Ammunition

From the main menu item “Define” choose “Supply” and then “Ammunition.” You will then be presented with the dialog shown in Figure 3-41. First, you need to select the scenario in which you want to set the ammunition supply. Then, using the “Add” button, you must select a Weapon System and fill in the remainder of the data elements. This includes the Transporter Name, the capacity of the transporter, the manpower required for the transporter, and the maximum number of trips the transporter makes in a single day.

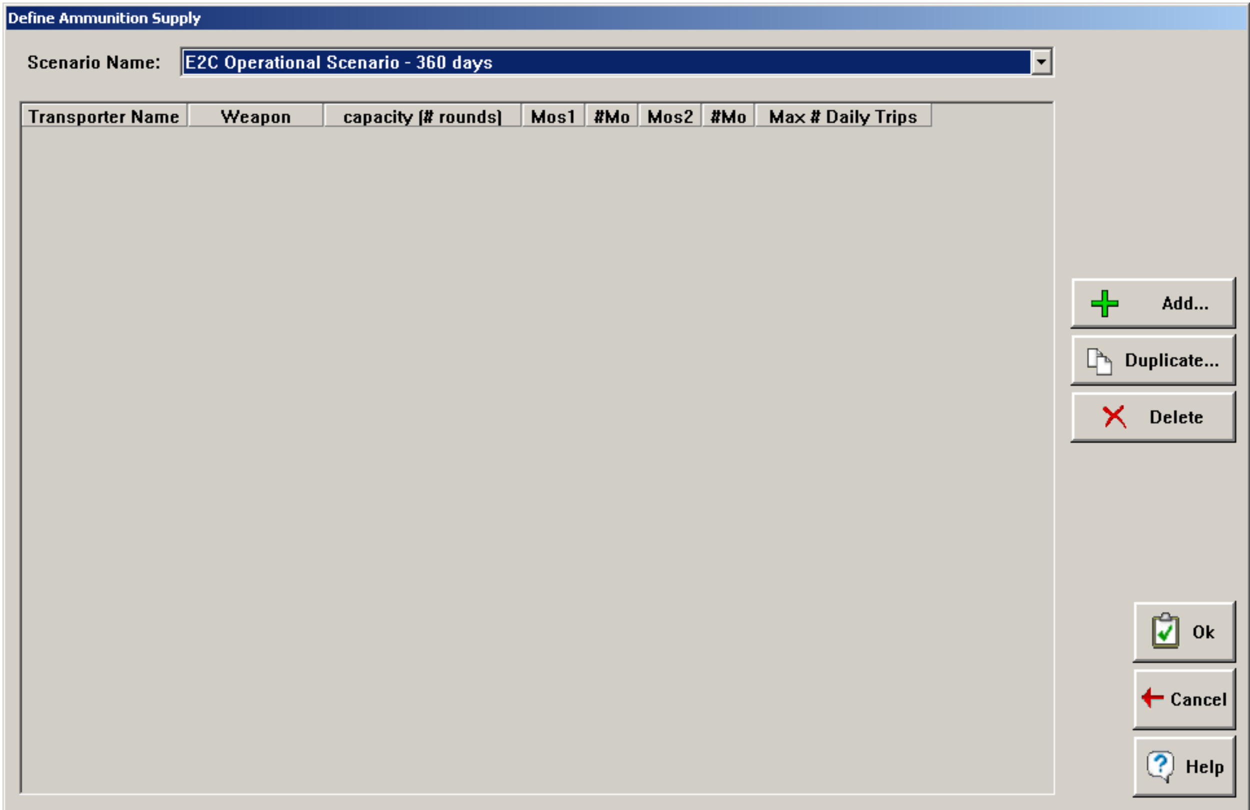


Figure 3-41. Define Ammunition Supply

Resources

This feature has not been implemented yet.

Options Menu

Edit Org Levels

This option allows you to change the names of the maintenance organizational levels. To edit an organizational level, first select this option from the menu. In the Edit Org Levels window that follows, click the cell containing the name you wish to change, type in a new name, then click the Ok button. You are limited to 10 characters. Once you edit these levels, the new names will show up on all interfaces and reports that refer to the maintenance organizational levels.

Overall Workload (VACP Missions only)

This option allows you to define an overall workload measure for VACP Missions using the interface shown in Figure 3-42.

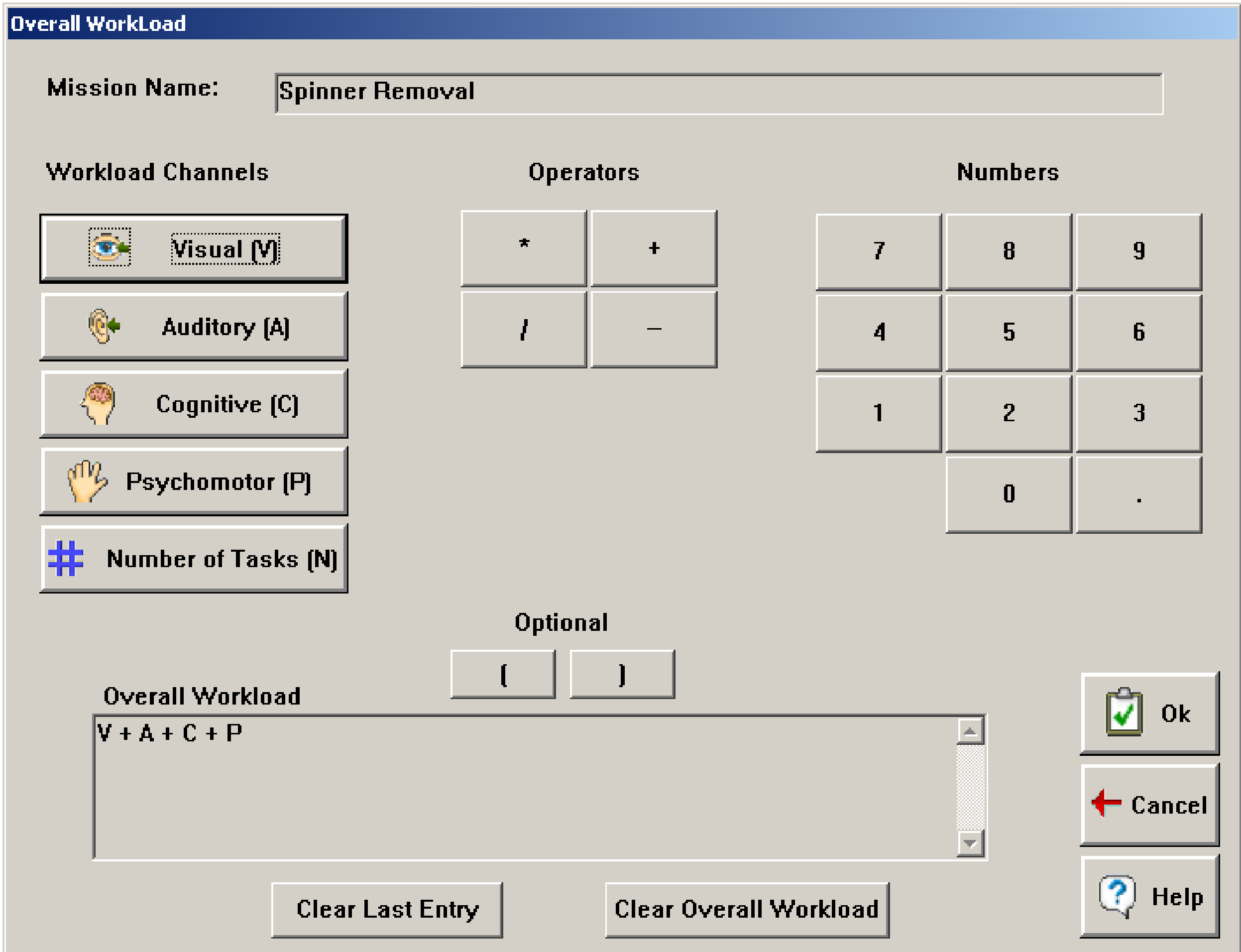


Figure 3-42. Overall Workload

In essence, it is used to combine the four workload channels into a single combined channel. For example, if you think that cognitive workload is twice as important as visual, psychomotor, and auditory in its contribution toward the total work an operator might feel, then you might be interested in tracking the value of an "Overall" channel that weights each of the existing channels to represent your hypothesis. Your "Overall" channel could be computed as follows:

O = 2 * C + V + P + A

where;

O = Overall

C = Cognitive

V = Visual

P = Psychomotor

A = Auditory

In the reports, where the results of the workload in each channel are indicated, it will include values for "O" as the mission timeline progresses.

Clear Last Entry Button

This button, when clicked, clears the last channel, operator, or number entered into the overall workload expression.

Clear Overall Workload Button

This button, when clicked, clears the entire overall workload expression in the overall workload text box.

High Workload Definitions (VACP Missions only)

The dialog shown in Figure 3-43 is used to establish the definition of high workload.

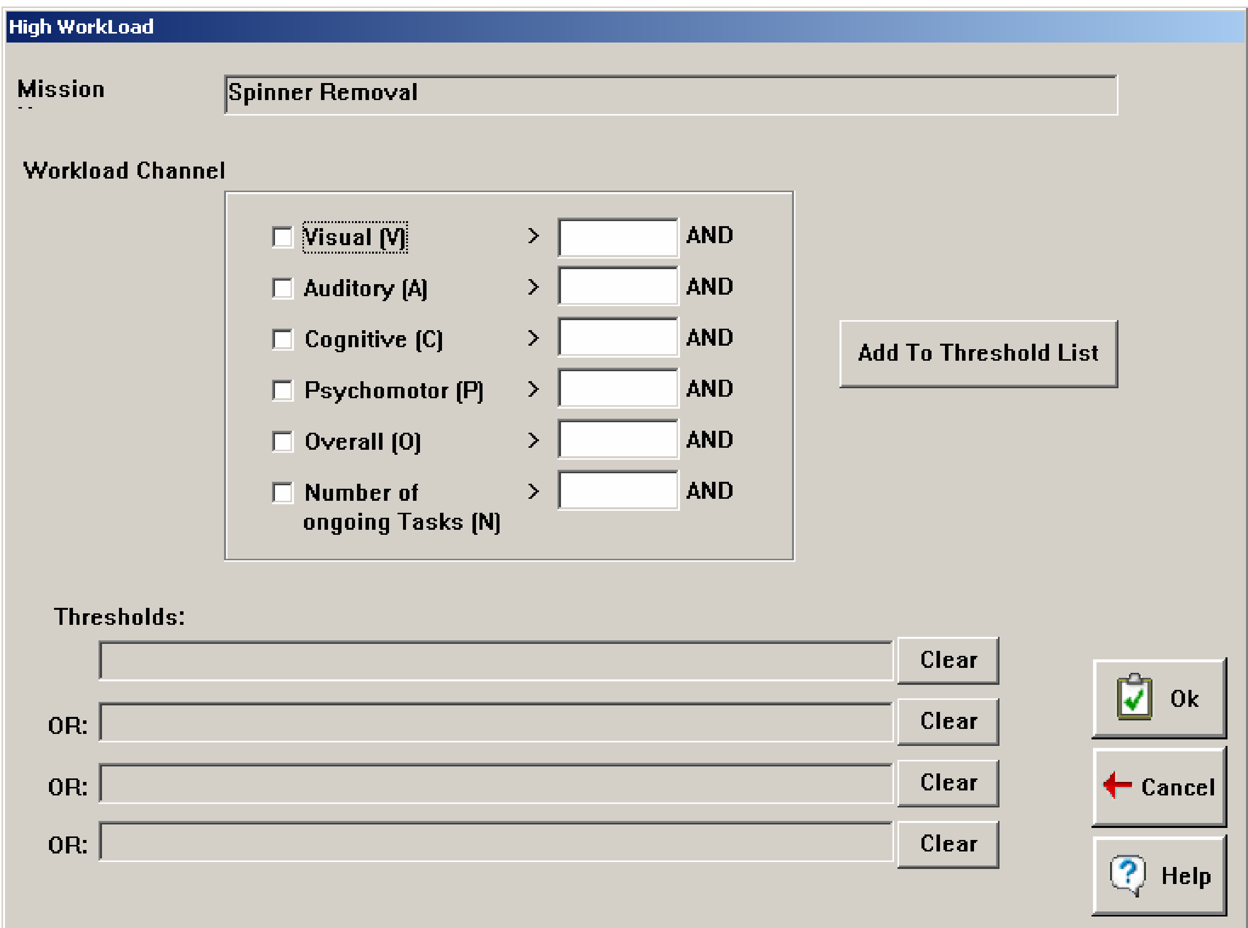


Figure 3-43. High Workload

High Workload Definitions are used to identify high workload levels for crewmembers. This is only applicable to VACP and Goal Oriented missions. When your IMPRINT system mission model runs, the current workload levels of each operator are added across all tasks that the operator is performing. The sum is compared to each of the high workload definitions. If the current workload meets or exceeds any of the definitions, that segment of the mission is marked as "high workload." Later, in the reports, you will be able to recall and study each point of "high workload." The report will also list the workload threshold that was violated.

You define high workload in terms of the individual workload channels (V = Visual, A = Auditory, C = Cognitive, P = Psychomotor), the overall channel (O), and the number of ongoing tasks for each operator (N). You can combine any or all of these terms in your definitions. For instance, if you want to define high workload as any time any operator is trying to perform more than two tasks at once, then your definition would be "N>2." If you want to define high workload as any time Auditory is more than 4 at the same time that Cognitive is more than 4, then your definition would be "A>4 & C>4." You can enter up to four separate high workload definitions.

Add to Threshold Button

Click on this button to move high workload channel definitions into the threshold box. Once in this box, the model will then record and report high workload based on the thresholds.

Map Workload to Taxons (VACP Missions only)

The purpose of this option is to enable you to convert any VACP Workload assignments you have made for your tasks into Taxon assignments. This automatic option could save you a lot of time.

IMPRINT uses the following relationships to make the conversions.

If you have entered workload values of:

- Visual 1.0, Visual 3.7, Visual 4.0, Visual 5.0, Visual 5.4 or Visual 7.0 then IMPRINT will assign this task to the Visual Taxon.

- Cognitive 1.0, Cognitive 1.2, Cognitive 3.7, Cognitive 4.6, Cognitive 5.3 or Cognitive 6.8, then IMPRINT will assign this task to the Information Processing Taxon.

- Cognitive 7.0, then IMPRINT will assign this task to the Numerical Taxon.

- Psychomotor 2.2, Psychomotor 4.6, Psychomotor 5.8 or Psychomotor 7.0, then IMPRINT will assign this task to the Fine Motor Discrete Taxon.

- Psychomotor 2.6, then IMPRINT will assign this task to the Fine Motor Continuous Taxon.

- Auditory 4.9, Auditory 6.6, Auditory 7.0, or Psychomotor 1.0, then IMPRINT will assign this task to the Oral Communications Taxon.

- Visual 5.9, or Psychomotor 6.5, then IMPRINT will assign this task to the Read & Write Communications Taxon.

Notice that none of the VACP workload scores map into either the Gross Motor Light or Gross Motor Heavy Taxons.

We recommend that you use either the Review Task spreadsheet or the Task Taxon Assignment capability to evaluate the assignments that IMPRINT made.

PTS

You can set Personnel Characteristics, Training Frequency, and Stressor (PTS) values under this IMPRINT option. We recommend that you access these capabilities in the same order of the tabs (i.e., P, then T, then S). This is because the Personnel Characteristics describe the attributes with which the soldiers who will man your system will arrive. Then, you can train those soldiers to perform the tasks. Finally, when the soldiers actually perform the tasks, they will be subjected to environmental stressors.

In all of these effects, IMPRINT calculates the impact of the PTS variable change on the estimated task performance (time and accuracy). The amount of impact is reported to you. If you then execute the maintenance or operations model with the Adjustments option checked, these “moderated” performance times and accuracies will be used by the model. If you do not check the Adjustments option, then the model will execute with the original task time and accuracy estimates that you entered under the Define Mission interfaces.

Specific technical information regarding the precise algorithms that are used in this module, as well as the source of these algorithms can be found in Adkins and Dahl (1993) and in a paper included in Appendix A of this User’s Guide.

Personnel Characteristics

From the main menu item “Options” choose “PTS.” You can then choose whether you want to apply the impact of personnel characteristics by individual task, or whether you want to apply them by MOS. Regardless of which you choose, you will be presented with the tabbed dialog shown in Figure 3-44. However, if you choose to apply them by MOS the individual task list will not be accessible. Note: If you have not assigned taxons to tasks, you will receive a message “There are no tasks with taxons assigned for this MOS.” Then IMPRINT will progress to the interface shown in the figure, above. Under “Function:” the text box will say “no parent.” You should then go back and assign taxons.

This option allows you to change the Armed Services Vocational Aptitude Battery (ASVAB) composite, the cutoff score, and the Mental Category level for the Military Occupational Specialty (MOS) performing the tasks. The current ASVAB composite and cutoff score used to select people for the MOS are shown initially in the dialog box. You can edit these values.

***Of note: Once a user has entered (‘Apply’) changes on the Personnel Characteristics screen, the software saves the Personnel Characteristics for that task in the DB. So when the user does change 1) the operator/MOS assignment for a task or 2) the MOS assignment for an operator, the software purposely keeps the already entered (‘Apply’) values.

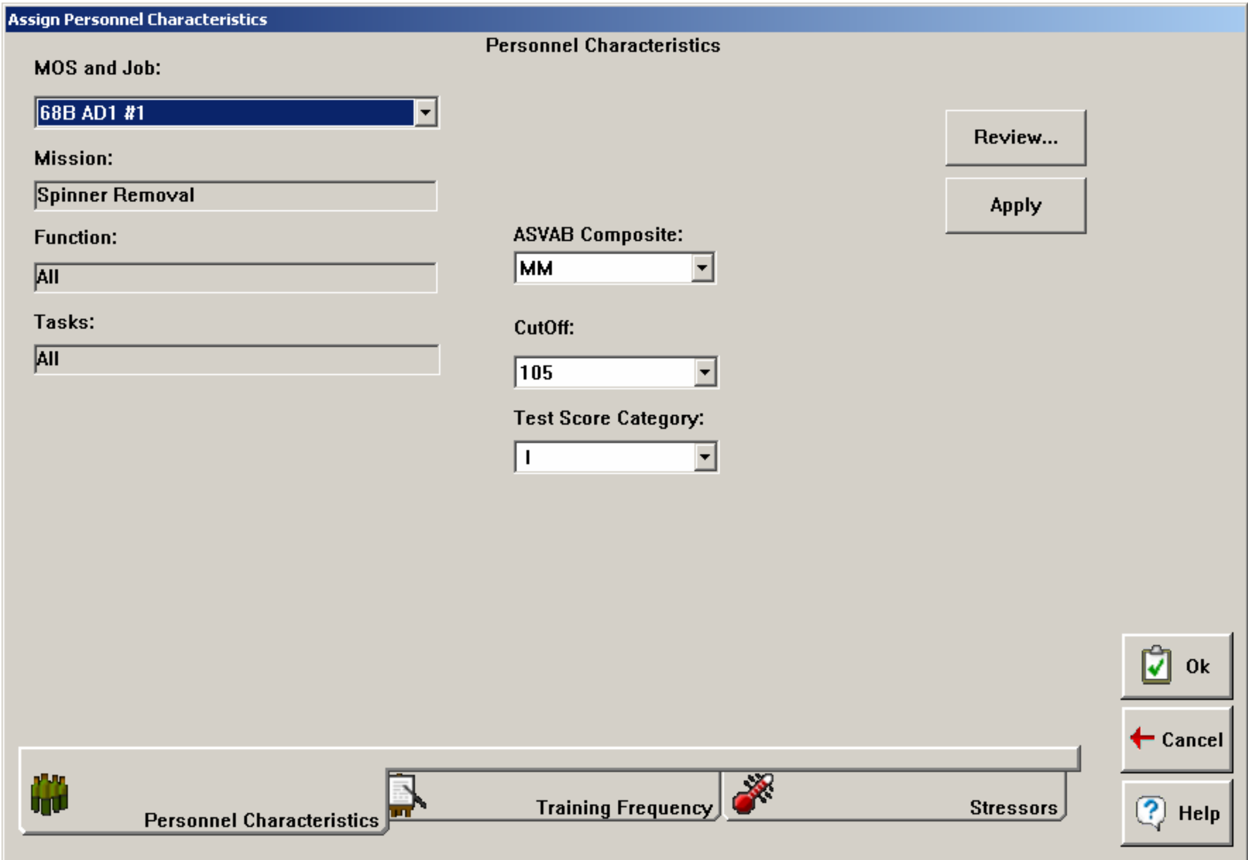


Figure 3-44. Assign Personnel Characteristics

If you change the ASVAB composite and cutoff score, you are, in effect, changing the MOS. This is because you have redefined the personnel characteristics of the MOS. Note that if you go back to the Task information (either under Define Equipment or Define System Mission) and change the MOS assignment, IMPRINT will connect the baseline performance time and accuracy estimates you make to that MOS. The only way to “simulate” a new MOS assignment and the impact it will have on task performance is through reassigning the ASVAB composite and cutoff on this screen.

There are two separate, but related options for setting minimum (i.e., cutoff) scores for personnel characteristics. Both options involve measures obtained from the Armed Services Vocational Aptitude Battery (ASVAB). The ASVAB is a battery of tests administered to enlistees prior to entering the military services. It is important to note that changes in the Test Score Category Cutoff will cause IMPRINT to automatically update the ASVAB Composite Cutoff to reflect the new Test Score Category that you have selected. IMPRINT will also automatically update the Test Score Category Cutoff to reflect changes to the ASVAB Composite Cutoff. The two options are as follows:

1. Change Test Score Category Cutoff - This option allows you to set a minimum "mental category" for a MOS and then see how performance would be affected. Mental category, now called "Test Score Category" refers to the general aptitude, and is from

the score obtained on the Armed Forces Qualification Test (AFQT), which is derived from the ASVAB.

The different Test Score Categories are:

Test Score Category	AFQT Score
I	93-99
II	65-92
IIIA	50-64
IIIB	31-49
IV	10-30

When you pick a Test Score Category cutoff, the MOS will include the chosen Test Score Category and all others above it (e.g., Choosing "IIIA" will result in the MOS having Mental Categories I, II, and IIIA). At the same time, IMPRINT will automatically estimate the ASVAB cutoff that is associated with the Test Score Category cutoff you select. Again, once you have selected and applied a particular Test Score Category you can see a report summarizing the impact that your choice has had on task Accuracy, Time, and the Probability of achieving the minimum acceptable accuracy by clicking on the “Review” button.

2. Change ASVAB Composite Cutoff - This option allows you to set a minimum ASVAB Composite score for the MOS and subsequently see how performance would be affected. The ASVAB itself consists of 10 subtests from which "composites" are constructed by combining two or more of the subtests. Each MOS uses one or two of the composites to control who can enter the MOS. This is done by setting composite cutoff scores, which must be attained in order to enter the MOS. Each MOS is assigned a composite(s) which is best for measuring the skills and aptitudes required to perform jobs well in the MOS.

When choosing an ASVAB composite cutoff score, you should realize that a higher cutoff score will generally result in better performance within the MOS. However, there will be fewer people available that can attain the higher cutoff score. Once you "Apply" your choices, you will see a report summarizing the impact that your Composite score changes have had on task Accuracy, Time, and the Probability of achieving the minimum acceptable accuracy.

ASVAB Composite

This option allows you to change the Armed Services Vocational Aptitude Battery (ASVAB) composite for the MOS performing the tasks. The ASVAB itself consists of 10 subtests from which "composites" are constructed by combining two or more of the subtests. The current ASVAB composite used to select people for the MOS is shown initially in the dialog box. You can select another ASVAB composite to be used from a drop down menu that will appear when you click on the drop down control.

ASVAB Cutoff

This option allows you to change the Armed Services Vocational Aptitude Battery (ASVAB) composite cutoff score for the MOS performing the tasks. The current ASVAB cutoff score used to select people for the MOS is shown initially in the dialog box. You can edit this value by selecting a different cutoff value from the drop down menu that will appear by clicking on that control. Higher cutoff scores will normally result in better performance but will cause fewer people to be available for the MOS.

Apply Button

When clicked, this button applies the chosen ASVAB composite cutoff. You should realize that a higher cutoff score will generally result in better performance within the MOS. However, there will be fewer people available that can attain the higher cutoff score. Once you "Apply" your choices and hit the “Review” button, you will see a report summarizing the new performance estimates and a “Delta” column that includes the impact that your changes have had on the MOST RECENT values for task accuracy, time, and the probability of achieving the minimum acceptable accuracy. So each time you press “Apply,” the performance estimates will be a combined calculation based on all PTS settings so far, and the Delta values will show the amount of change from the immediately preceding “Apply” button click. If you want to “Unapply” your choices, you must go back to the combo boxes where the settings were changed, adjust them so that they are in the N/A or 0 levels, and “Apply” these values again.

Review Button

Click on this button to review any effects on task performance of applying personnel characteristics changes to your MOS’.

<u>Training Frequencies</u>

From the main menu item “Options” choose “PTS.” You can then choose whether you want to apply the impacts of training frequencies by individual task, or whether you want to apply them by MOS. Regardless of which you choose, you will be presented with the tabbed dialog shown in Figure 3-45. Training frequencies are on the second tab.

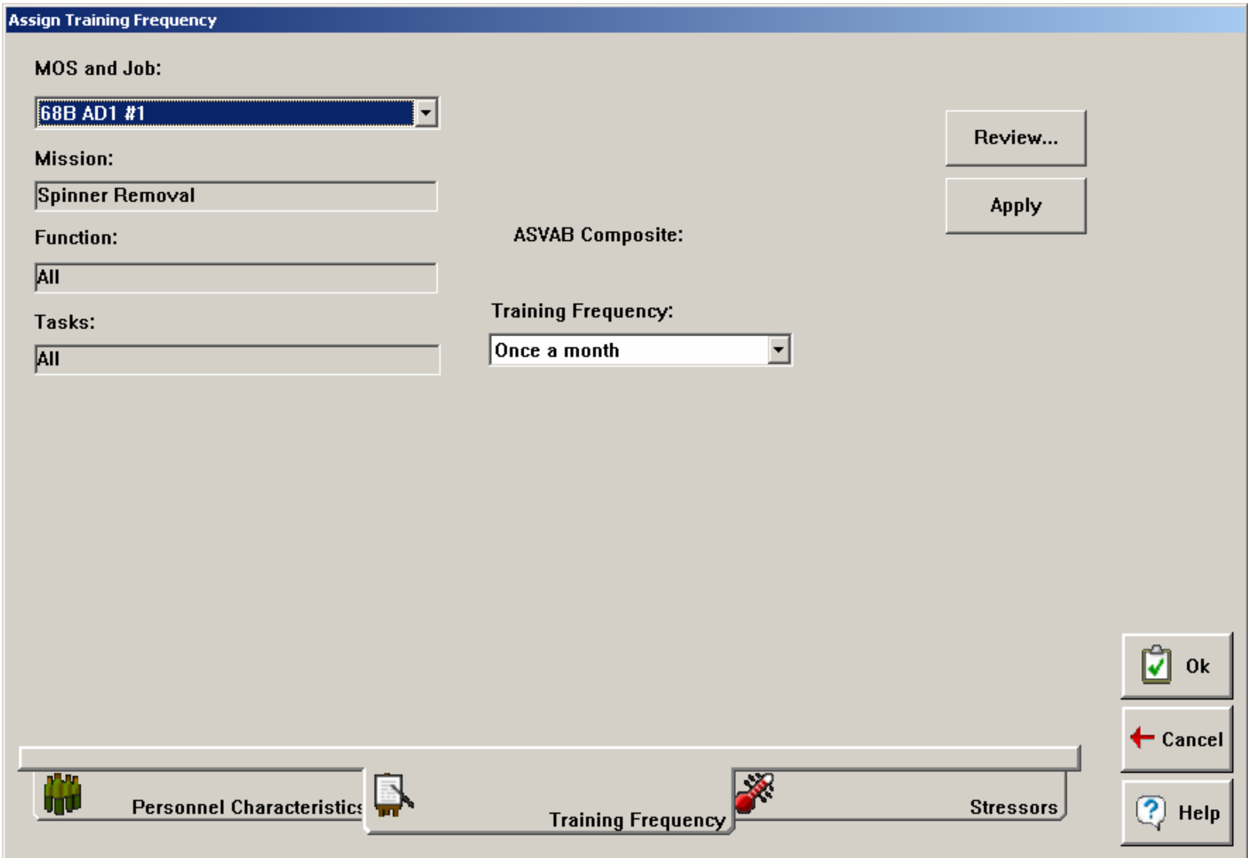


Figure 3-45. Assign Training Frequency

This option allows you to review and edit training frequencies for each task. One of five training levels can be assigned to a task. You should choose the training level which best describes how often operators or maintainers will perform the task. Performance of the task could be part of a training exercise or actual job performance. In general, the more frequently an individual practices or performs a task, the more accurately they will perform it. In addition, an increase in training frequency normally will decrease the time required to perform the task.

If you are trying to improve task performance to meet accuracy or time standards, increasing training frequency is one possible alternative. An increase in training frequency, however, will often require additional resources (e.g., an increase in the frequency with which soldiers zero the sights of their weapons will require more ammunition).

If you do not assign sustainment training frequencies to tasks, the average (i.e. once a month) will be assigned automatically.

In order to see the effects of changing training frequencies you should click on the "Apply" button, to apply the changes, and then the "Review" button on the "Assign Training Frequencies" dialog box. Once you have finished applying a training frequency, it is recorded for that particular Task or MOS and can be referred to or edited later by choosing "PTS" from the main menu item "Options."

It is important to note that any training frequency changes that you make may alter the stored accuracy, time, and/or probability values that IMPRINT has for that particular task or MOS, within your analysis. If you make training frequency changes, IMPRINT will produce a "Delta" Report that will show you how task performance has been changed. When this "Delta" Report is produced, you should save the contents of this report (by selecting the data in the report using your mouse, and then pressing “Ctrl C” for copy, going to Excel and pressing “Ctrl-V” for paste) in order to maintain a record of your changes. This record is important because you can make further changes in other places in IMPRINT. As these changes add up, it can be difficult, if not impossible, to regain your initial values. You should save any subsequent "Delta" Reports as well.

Apply Button

When clicked, this button applies the training frequency. You should realize that more frequent training will generally result in better performance within the MOS. Once you "Apply" your choices and hit the “Review” button, you will see a report summarizing the new performance estimates and a “Delta” column that includes the impact that your changes have had on the MOST RECENT values for task accuracy, time, and the probability of achieving the minimum acceptable accuracy. So each time you press “Apply,” the performance estimates will be a combined calculation based on all PTS settings so far, and the Delta values will show the amount of change from the immediately preceding “Apply” button click. If you want to “Unapply” your choices, you must go back to the combo boxes where the settings were changed, adjust them so that they are in the N/A or 0 levels, and “Apply” these values again.

Review Button

Click on this button to review task performance effects of applying training frequency changes to your tasks.

Stressors

From the main menu item “Options” choose “PTS.” You can then choose whether you want to apply the impacts of stressors by individual task, or whether you want to apply them by MOS. Regardless of which you choose, you will be presented with the tabbed dialog shown in Figure 3-46. Stressors are on the third tab.

This option allows you to review and change stressors. Five different stressors can be applied to tasks. They are: Mission Oriented Protective Posture (MOPP) gear for individual nuclear, biological, and chemical defense; heat; cold; noise; and sustained operations (i.e., lack of sleep). Stressors may be reviewed and changed for each individual task one at a time, or for an entire group of tasks all at once. Depending upon the specifics of the task and MOS, adding stressors may decrease task accuracy and/or increase the time it takes to complete the task.

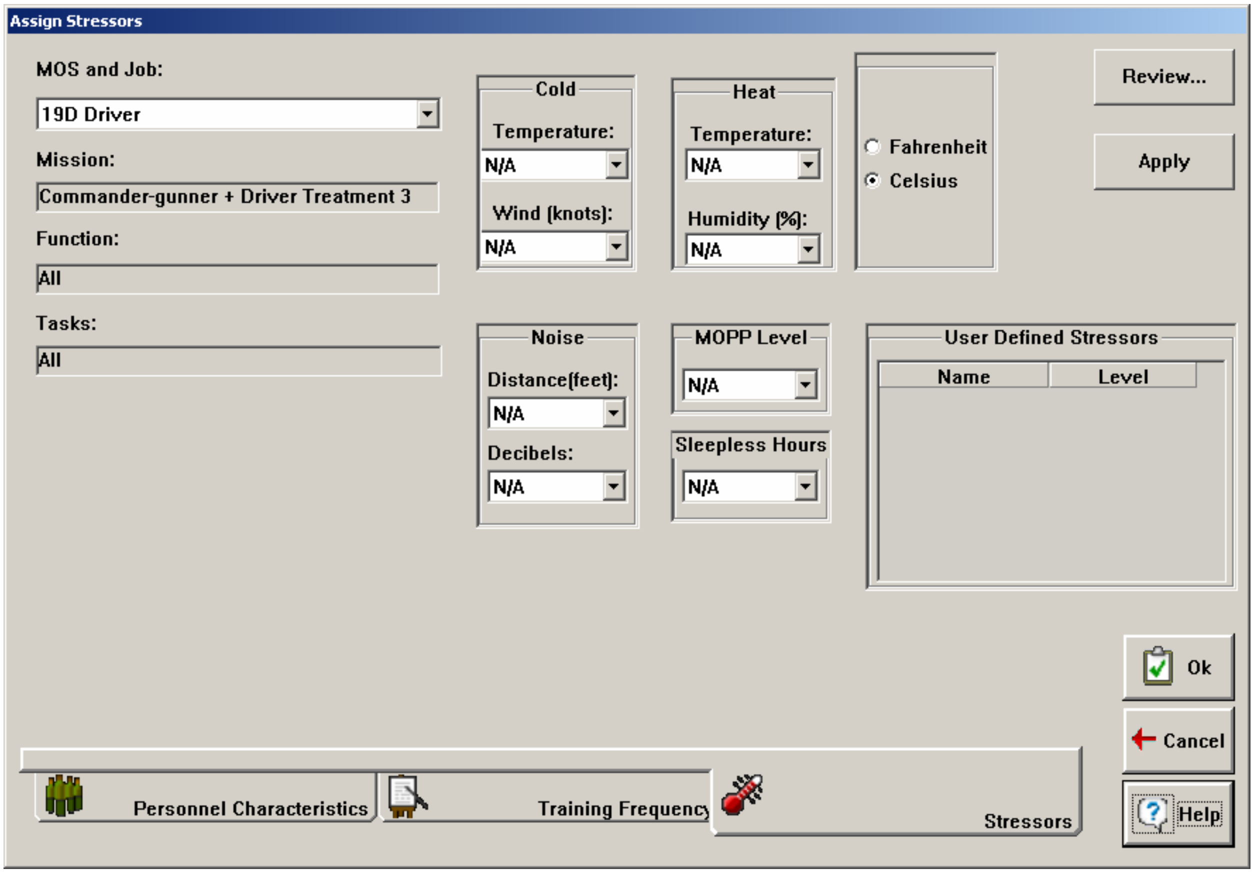


Figure 3-46. Assign Stressors

In order to see the effects of stressors you should apply them one at a time. To see the effects of applying stressors you should click on the "Review" button on the "Assign Stressors" dialog box. Once you have finished applying a stressor, it is recorded for that particular Task or MOS and can be referred to or edited later by choosing "PTS" from the main menu item "Options."

It is important to note that any stressors that you apply may alter the stored accuracy, time, and/or probability values that IMPRINT has for that particular task or MOS, within your analysis. If you apply stressors, IMPRINT will produce a "Delta" Report that will show you how task performance has been changed. When this "Delta" Report is produced, you should save the contents of this report (by selecting the data in the report using your mouse, and then pressing "Ctrl C" for copy, going to Excel and pressing "Ctrl-V" for paste) in order to maintain a record of your changes. This record is important because you can make further changes in other places of IMPRINT. As these changes add up, it can be difficult, if not impossible to regain your initial values. You should save any subsequent "Delta" Reports as well.

The table below indicates the impact of stressors by taxon.

TAXON	MOPP	Heat	Cold	Noise	Sleepless Hours
Visual	T	A	T		
Numerical		A			TA
Cognitive		A			TA
Fine Motor Discrete	T	A	T		
Fine Motor Continuous					
Gross Motor Light	T		T		
Gross Motor Heavy					
Commo (Read & Write)		A			
Commo (Oral)	T	A		A	

T = Affects task time. A = Affects task accuracy. TA = Affects both.

If you apply more than one stressor to the same task, then a power function is applied. This means that the most severe stressor will have full effect, and the others have less. More information regarding the relevant calculations can be found in the HARDMAN III Final Report (Adkins and Dahl, 1993).

Stressors may be reviewed and changed for each individual task, one at a time, or, for an entire group of tasks, all at once. Depending upon the specifics of the task and MOS, adding stressors may decrease task accuracy and/or increase the time it takes to complete the task.

Cold

This option allows you to change the temperature and wind speed for the environment in which individuals are performing operator and maintainer tasks. Click on the drop down box to get the selectable values. Then click on a value to select it.

Heat

This option allows you to change the temperature and humidity for the environment in which individuals are performing operator and maintainer tasks. Click on the drop down box to get the selectable values. Then click on a value to select it.

Temperature Scale Selection

Clicking on the Fahrenheit radio button changes all temperatures related data to the Fahrenheit scale. Clicking on the Celsius radio button changes all temperatures related data to the Celsius scale.

Noise

This option allows you to change the decibel level at the ear, and the distance between communicators for the environment in which individuals are performing operator and maintainer tasks. Stressors may be reviewed and changed for each individual task, one at a time, or for an entire group of tasks all at once. Depending upon the specifics of the task and MOS, adding stressors may decrease task accuracy and/or increase the time it takes to complete the task.

MOPP Level

This option allows you to change the level of the Mission Oriented Protective Posture (MOPP) gear for individual nuclear, biological, and chemical defense.

Sleepless Hours

This option allows you to change the hours last slept for individuals that are performing operator and maintainer tasks.

User Defined Stressors

This option allows you to select from Stressors that you have defined in the User Defined Stressors feature from the Options menu. Here you can select the User Defined Stressor and the desired level for that stressor.

Apply Button

When clicked, this button applies the chosen ASVAB composite cutoff score, stressor combination, or training frequency. You should realize that a higher cutoff score will generally result in better performance within the MOS. However, there will be fewer people available that can attain the higher cutoff score. Once you "Apply" your choices and hit the “Review “ button, you will see a report summarizing the new performance estimates and a “Delta” column that includes the impact your changes have had on the MOST RECENT values for task accuracy, time, and the probability of achieving the minimum acceptable accuracy. So each time you press “Apply,” the performance estimates will be a combined calculation based on all PTS settings so far, and the Delta values will show the amount of change from the immediately preceding “Apply” button click. If you want to “Unapply” your choices, you must go back to the combo boxes where the settings were changed, adjust them so that they are in the N/A or 0 levels, and “Apply” these values again.

Review Button

Clicking on this button allows you to review any effects on task performance of applying stressors.

User Defined Stressors

IMPRINT users can now define their own stressors. You can do this by selecting User 'Defined Stressors…' from the Options Menu. From here you will need to add a new stressor. Then select the Define button in order to get to the interface where you can create different levels and corresponding algorithms for the stressor. This interface is shown in Figure 3-47.

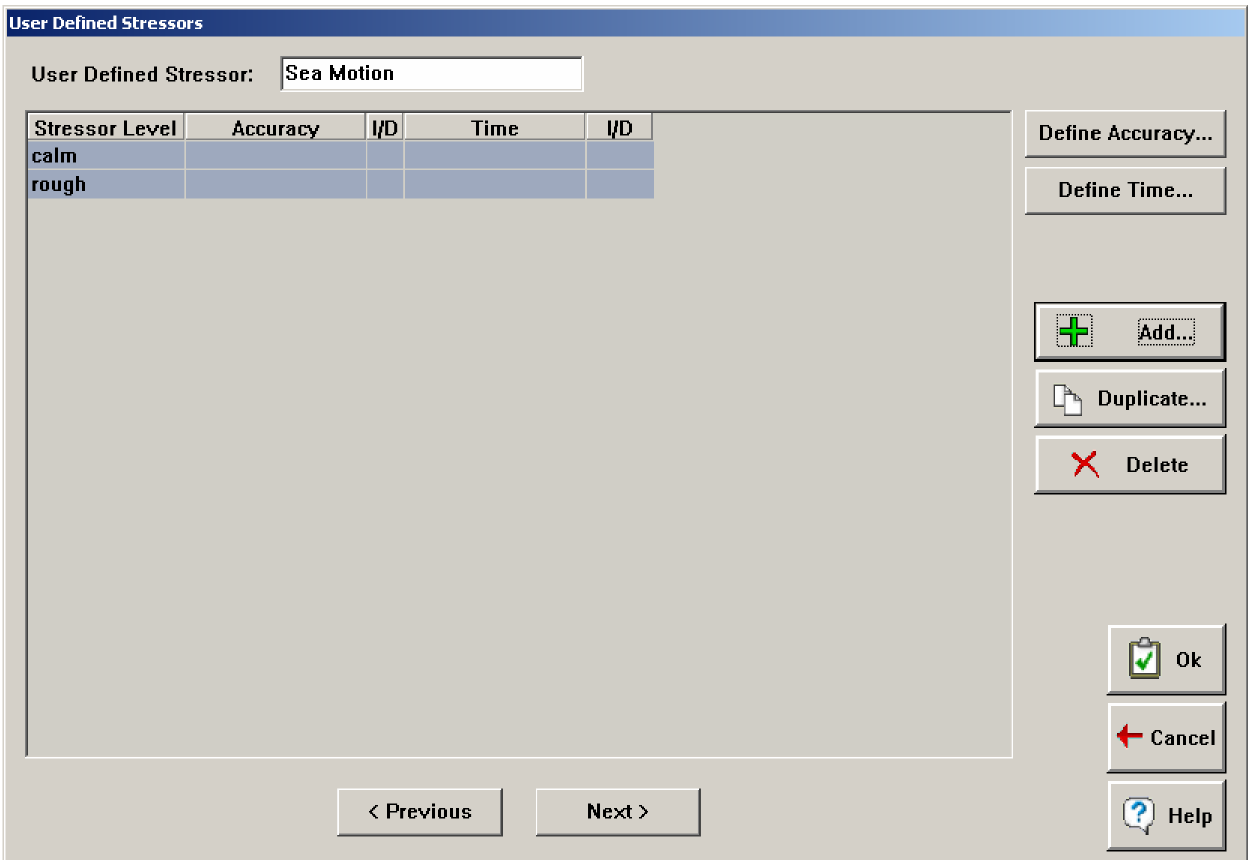


Figure 3-47. User Defined Stressors

To add new levels simply click the Add button and enter in a name for the level. You are limited to five levels per stressor. Once you have added all your levels you can click on a level and define its Time and Accuracy effects. Clicking on Define Time or Define Accuracy brings you to the interface shown in Figure 3-80.

Define Time and Define Accuracy

When defining time/accuracy you will need to first decide whether the stressor will decrease or increase task time or accuracy by selecting the appropriate radio button. If you select increase, the task time/accuracy will be multiplied by (1 + the value of the algorithm you create), and when you select decrease, the task time/accuracy will be multiplied by (1 - the value of the algorithm you create). For example, if you select increase in the Define Time Stressor interface, then when you apply your stressor it will increase the time it takes for the task to complete. If you select decrease in the Define Accuracy Stressor interface, then the task accuracy will be decreased when you apply the stressor. Note that if you select the decrease option in the Define Time Stressor interface, it is possible to create a negative factor and applying this stressor would result in a negative task time. Also, if you select the increase option in the Define Accuracy Stressor interface, it is possible to create a factor that would result in a task accuracy greater than 100.

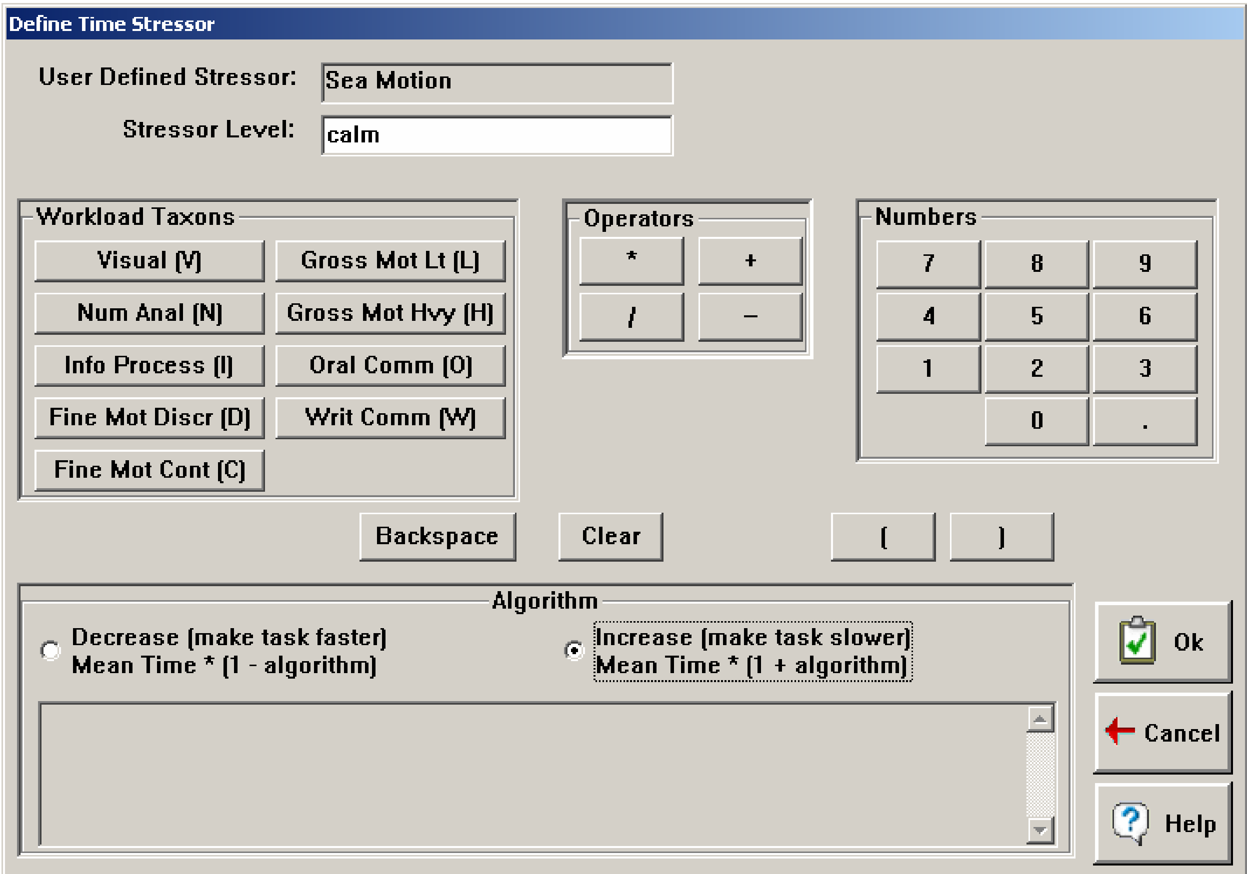


Figure 3-48. Define Time Stressor Interface

To define the algorithm, simply create an equation using the buttons provided in the interface in Figure 3-48. Decimal points must follow a number. Operators must follow and number or workload taxon. The workload taxons you enter into the equation refer to the weights given to the taxons in individual tasks.

In order to apply User Defined Stressor(s) you need to go to PTS from the Options Menu. Click on the Stressors tab and select the desired level of stress from the drop down list. Then click Apply. It is a good idea to click Review after you've applied a stressor to make sure that this has not resulted in a negative task time or a task accuracy greater than 100.

Review Function Data

The purpose of this spreadsheet, shown in Figure 3-49, is to enable you to view all the function data in a tabular format. These data are sorted in order of increasing function identification numbers. The spreadsheet scrolls left and right so that you can view all the columns. In addition, you can change the widths of the columns by moving your cursor to the row that includes the column names. Then click and hold the button down on the divisions between columns, and slide the cursor left or right while holding the button down to resize the column.

You cannot edit all the columns on this display. However, you can change the function time standard and the function criterion data element values.

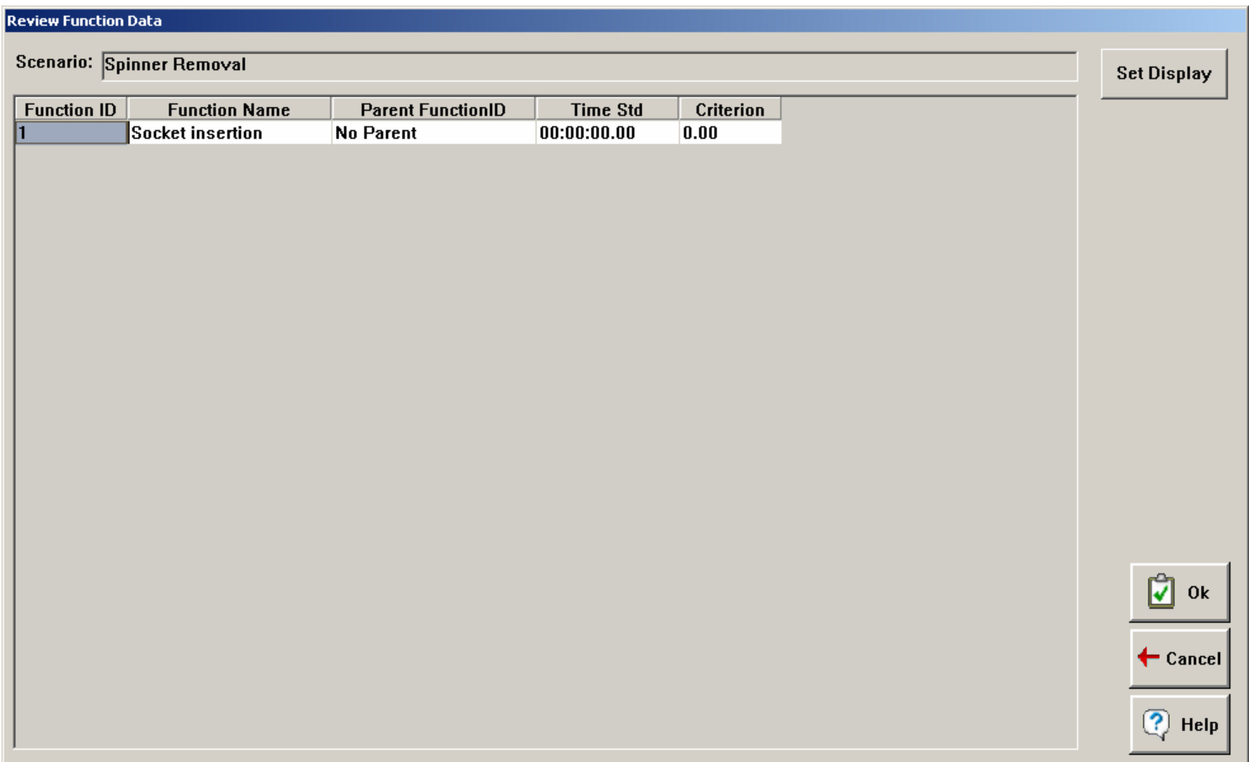


Figure 3-49. Review Function Data

You can use the standard Windows shortcut editing keys to paste data into this spreadsheet. This is handy if you have entered the data in an application such as Excel. You just need to be sure that the columns in your source spreadsheet are in the same order and each column is in the same format (e.g., 00:00:00.00 for time values) as IMPRINT expects. This will probably require that you format the entire sheet to a text format, so that 00:30:00.00 does not get translated to 30:00.00. Then, go to your application and select the data that you want to paste into IMPRINT and copy it to the clipboard, using Ctrl-C. Then, open the "Review" spreadsheet, select the area into which you want to paste the data, and press Ctrl-V. Be sure to double-check that the data are in the cells that you want.

Set Display Button

As you can see, there are many more columns on the spreadsheet than will fit into the workspace window. You can choose to display selected columns to customize the display for your needs by clicking on the Set Display button. You can then select the columns you wish to display.

Review Task Data

Operator

The purpose of the spreadsheet shown in Figure 3-50 is to enable you to view all the task data in a tabular format. These data are sorted in order of increasing function and task identification numbers. The spreadsheet scrolls left and right so that you can view all the columns. In addition, you can change the widths of the columns by moving your cursor to the row that includes the column names. Then click and hold the button down on the divisions between columns, and slide the cursor left or right while holding the button down to resize the column.

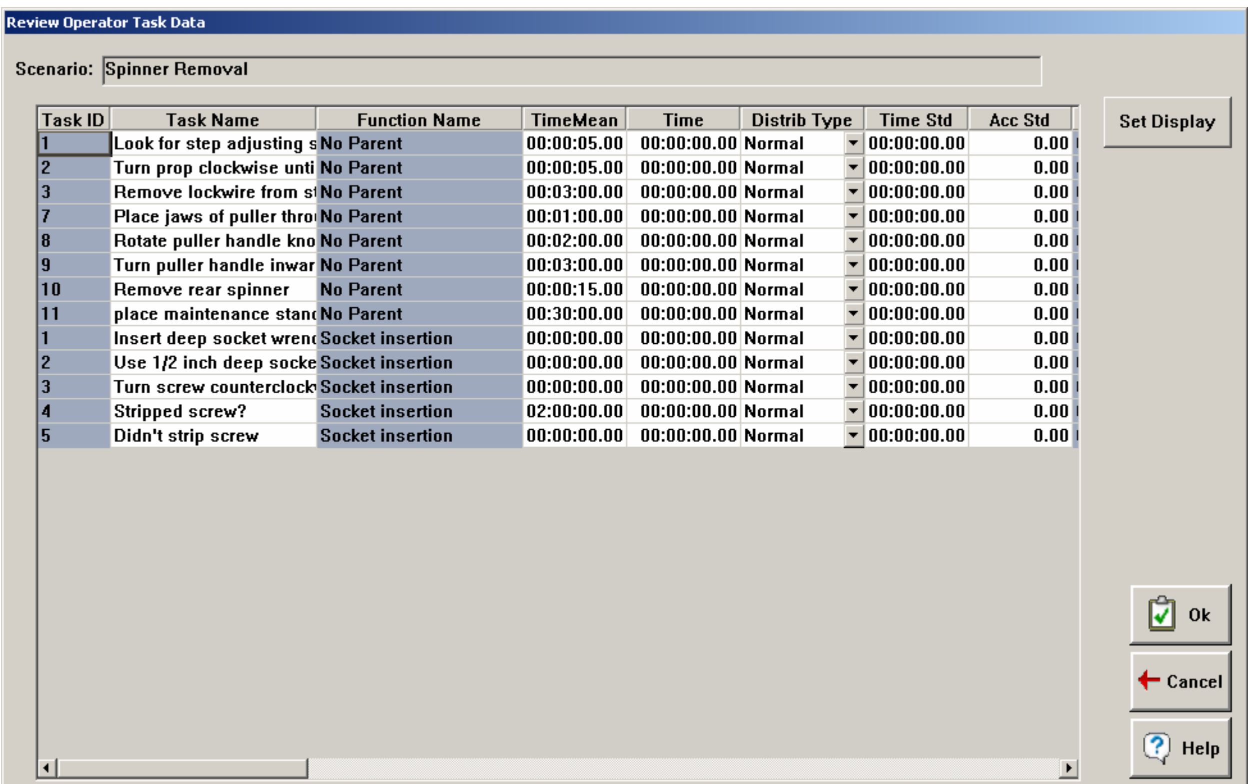


Figure 3-50. Review Task Data

You cannot edit all the columns on this display. For instance, you cannot change the Task ID or the parent function. However, you can change most of the task performance data.

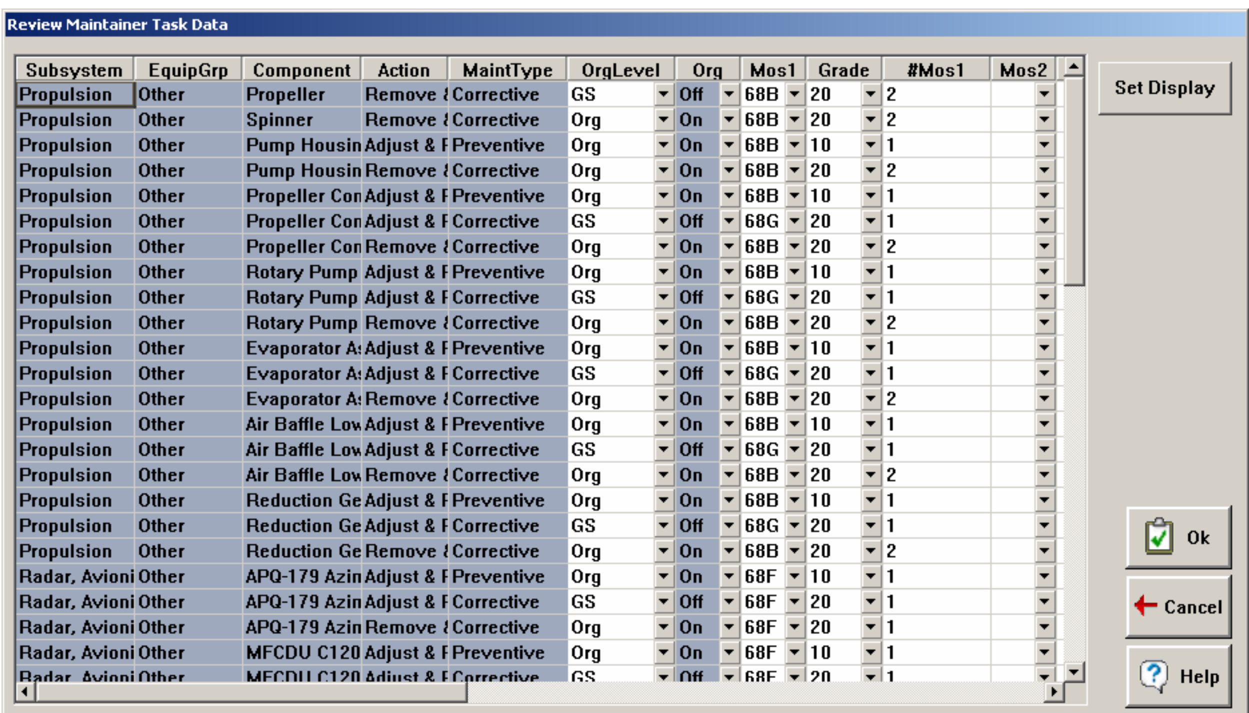
You can use the standard Windows shortcut editing keys to paste data into this spreadsheet. This is handy if you have entered the data in an application such as Excel. You just need to be sure that the columns in your source spreadsheet are in the same order and each column is in the same format (e.g., 00:00:00.00 for time values) as IMPRINT expects. This will probably require that you format the entire sheet to a text format, so that 00:30:00.00 does not get translated to 30:00.00. Then, go to your application and select the data that you want to paste into IMPRINT and copy it to the clipboard, using Ctrl+C. Then, open the "Review" spreadsheet, select the area into which you want to paste the data, and press Ctrl+V. Be sure to double-check that the data are in the cells that you want.

Set Display Button

As you can see, there are many more columns on the spreadsheet than will fit into the workspace window. You can choose to display selected columns to customize the display for your needs by clicking on the “Set Display” button. You can then select the columns you wish to display.

<u>Maintainer</u>

The purpose of the spreadsheet shown in Figure 3-51 is to enable you to view all the maintenance task data in a tabular format. These data are sorted in alphabetical order by subsystem. The spreadsheet scrolls left and right so that you can view all the columns. Also, you can change the widths of the columns by moving your cursor to the row that includes the column names. Then click and hold the button down on the divisions between columns, and slide the cursor left or right while holding the button down to resize the column.



Subsystem	EquipGrp	Component	Action	MaintType	OrgLevel	Org	Mos1	Grade	#Mos1	Mos2
Propulsion	Other	Propeller	Remove {	Corrective	GS	Off	68B	20	2	
Propulsion	Other	Spinner	Remove {	Corrective	Org	On	68B	20	2	
Propulsion	Other	Pump Housin	Adjust & F	Preventive	Org	On	68B	10	1	
Propulsion	Other	Pump Housin	Remove {	Corrective	Org	On	68B	20	2	
Propulsion	Other	Propeller Con	Adjust & F	Preventive	Org	On	68B	10	1	
Propulsion	Other	Propeller Con	Adjust & F	Corrective	GS	Off	68G	20	1	
Propulsion	Other	Propeller Con	Remove {	Corrective	Org	On	68B	20	2	
Propulsion	Other	Rotary Pump	Adjust & F	Preventive	Org	On	68B	10	1	
Propulsion	Other	Rotary Pump	Adjust & F	Corrective	GS	Off	68G	20	1	
Propulsion	Other	Rotary Pump	Remove {	Corrective	Org	On	68B	20	2	
Propulsion	Other	Evaporator A:	Adjust & F	Preventive	Org	On	68B	10	1	
Propulsion	Other	Evaporator A:	Adjust & F	Corrective	GS	Off	68G	20	1	
Propulsion	Other	Evaporator A:	Remove {	Corrective	Org	On	68B	20	2	
Propulsion	Other	Air Baffle Low	Adjust & F	Preventive	Org	On	68B	10	1	
Propulsion	Other	Air Baffle Low	Adjust & F	Corrective	GS	Off	68G	20	1	
Propulsion	Other	Air Baffle Low	Remove {	Corrective	Org	On	68B	20	2	
Propulsion	Other	Reduction Ge	Adjust & F	Preventive	Org	On	68B	10	1	
Propulsion	Other	Reduction Ge	Adjust & F	Corrective	GS	Off	68G	20	1	
Propulsion	Other	Reduction Ge	Remove {	Corrective	Org	On	68B	20	2	
Radar, Avioni	Other	APQ-179 Azin	Adjust & F	Preventive	Org	On	68F	10	1	
Radar, Avioni	Other	APQ-179 Azin	Adjust & F	Corrective	GS	Off	68F	20	1	
Radar, Avioni	Other	APQ-179 Azin	Remove {	Corrective	Org	On	68F	20	1	
Radar, Avioni	Other	MFCDU C120	Adjust & F	Preventive	Org	On	68F	10	1	
Radar, Avioni	Other	MFCDU C120	Adjust & F	Corrective	GS	Off	68F	20	1	

Figure 3-51. Review Maintainer Task Data

You cannot edit all the columns on this display. For instance, you cannot change the Subsystem Name, Component Name, Maintenance Task, and Maintenance Type (Preventive or Corrective). However, you can change most of the maintenance task performance data.

You can use the standard Windows shortcut editing keys to paste data into this spreadsheet. This is handy if you have entered the data in an application such as Excel. You just need to be sure that the columns in your source spreadsheet are in the same order and each column is in the same format (e.g., 00:00:00.00 for time values) as IMPRINT expects. Then, go to your application and select the data that you want to paste into IMPRINT and copy it to the clipboard, using Cntrl-C. Then, open the "Review" spreadsheet, select the area into which you want to paste the data, and press Cntrl-V. Be sure to double-check that the data are in the cells that you want.

Set Display Button

As you can see, there are many more columns on the spreadsheet than will fit into the workspace window. You can choose to show selected columns to customize the display for your needs by clicking on the Set Display button. You can then select the columns you wish to display.

Execute Menu

Operations Model

To begin executing the model, choose the “Operations Model...” option from the “Execute” menu. When you make this menu selection, IMPRINT will load the data for the operations mission model and display the mission name, as shown in Figure 3-52.

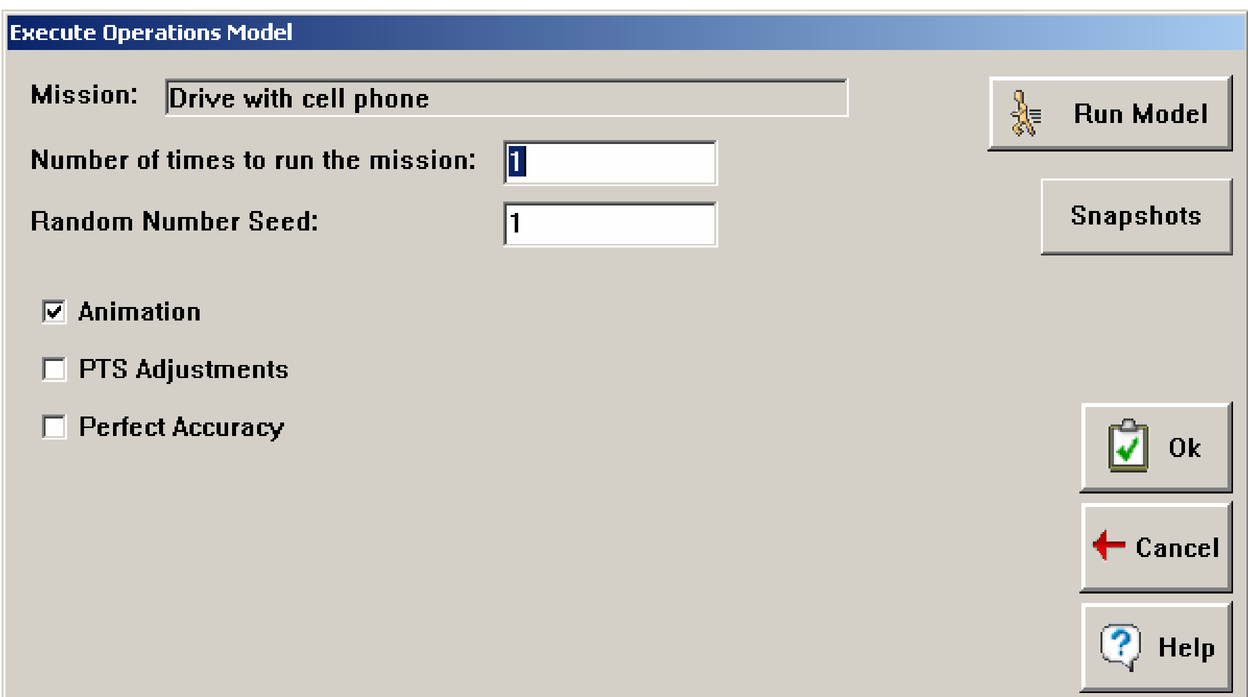


Figure 3-52. Execute Operations Model

You may then select the number of times to run the mission and the random number seed that will be used. The default number of times to run the mission is one.

There are several additional options from which to choose. You can turn animation on so that your network schematic is displayed as the model runs. You may select “PTS Adjustments” to use the task times and accuracies that were adjusted as a result of the combined applied Personnel Characteristics, Training Frequencies and Stressors. Finally, you can set an option that will run the model with perfect accuracy. This is sometimes useful when debugging your mission model.

The check boxes in the right-hand column of the screen allow you to enact the moderators defined under the Crew button, described under the Define Mission portion of this manual.

To begin execution of the model, click on the "Run Model" button.

For more technical information, see Technical Description of Operations Model.

Maintenance Model

To begin executing the maintenance model, choose the “Maintenance Model...” option from the “Execute” menu. When you make this menu selection, IMPRINT will load the data for the maintenance model and display the dialog shown in Figure 3-53.

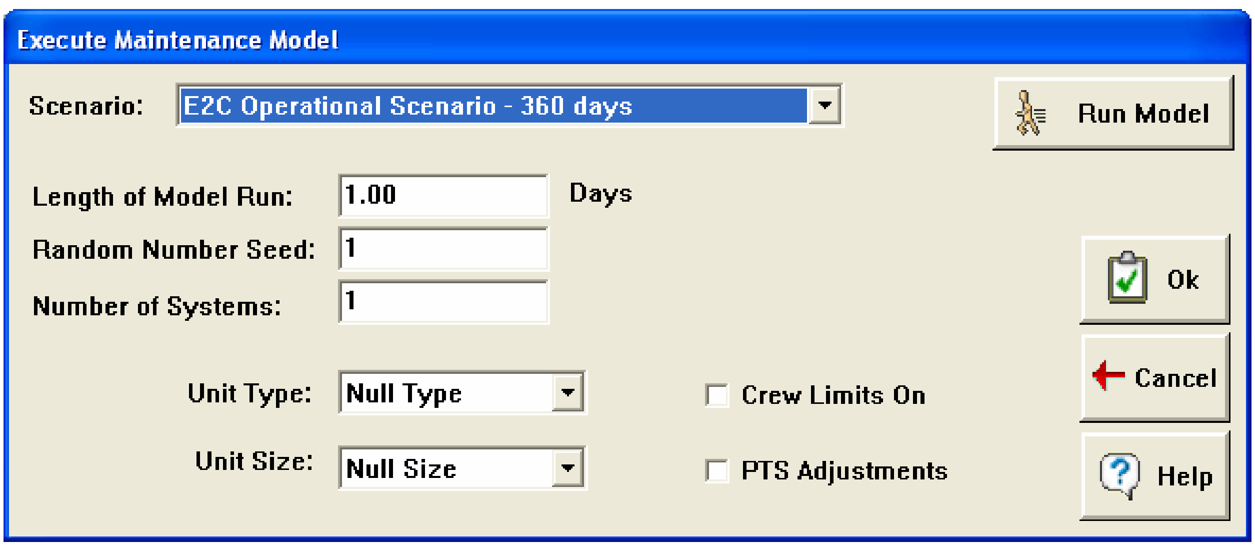


Figure 3-53. Execute Maintenance Model

Use the combo box at the top of the dialog to select the scenario you want to execute. You may then select the time period over which to execute your model and the Random Number Seed that will be used. The default time period is one day. You also can select the Number of Systems to run. The number of systems defaults to one.

You may select to run the maintenance model with or without adjustments. If you check "Adjustments" any applications of stressors, training frequency, or personnel characteristics will be used to modify Mean Time to Repair (MTTR) data for each task. If you do not check adjustments, the maintenance model will be run with the original (or baseline) MTTR data. To begin execution of the model, click on the "Run Model" button.

See also Maintenance Model.

Reports Menu

To review one or more of the many reports in IMPRINT pertaining to a model that you have just run, click the “Reports” menu at the top of the IMPRINT screen. You will then be presented with a secondary menu from which you can select the type of report (e.g., Operations Results, Maintenance Results, Force Structure Results, etc.) to be reviewed. When you make this menu selection, you will be presented with an additional interface displaying all available reports for the type you selected. By checking the report options you want and clicking the “OK” button, IMPRINT creates a new Microsoft Excel workbook that contains a separate worksheet for each selected report and graph. A sample report workbook is shown in the following figure:

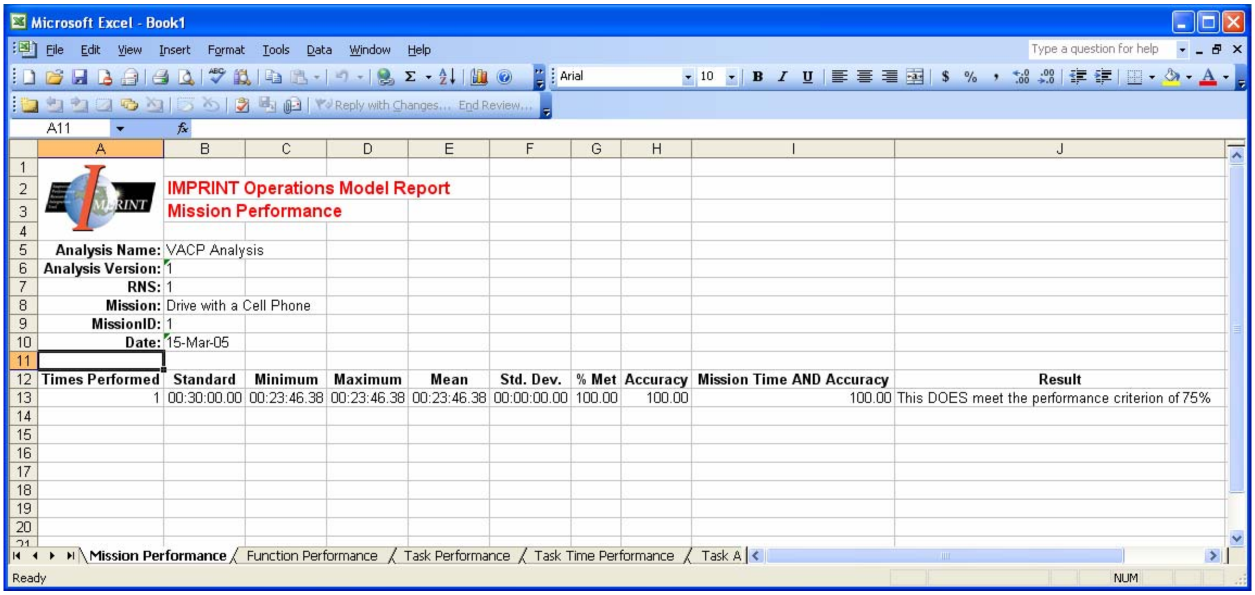


Figure 3-54. Sample Report Workbook

Each report can be accessed by clicking on its corresponding tab at the bottom of the workbook. You can obtain a printed copy of the report by selecting the Print icon located at the top of the screen in the toolbar.

Operations Model Results

VACP Models

Several reports are available after a VACP Mission has completed. To display reports, go to the Reports Menu at the top of the screen and select the Operational Results… option. Next, you will be presented with the following dialog displaying all report options. Check the reports you wish to see, and then click the Ok button.

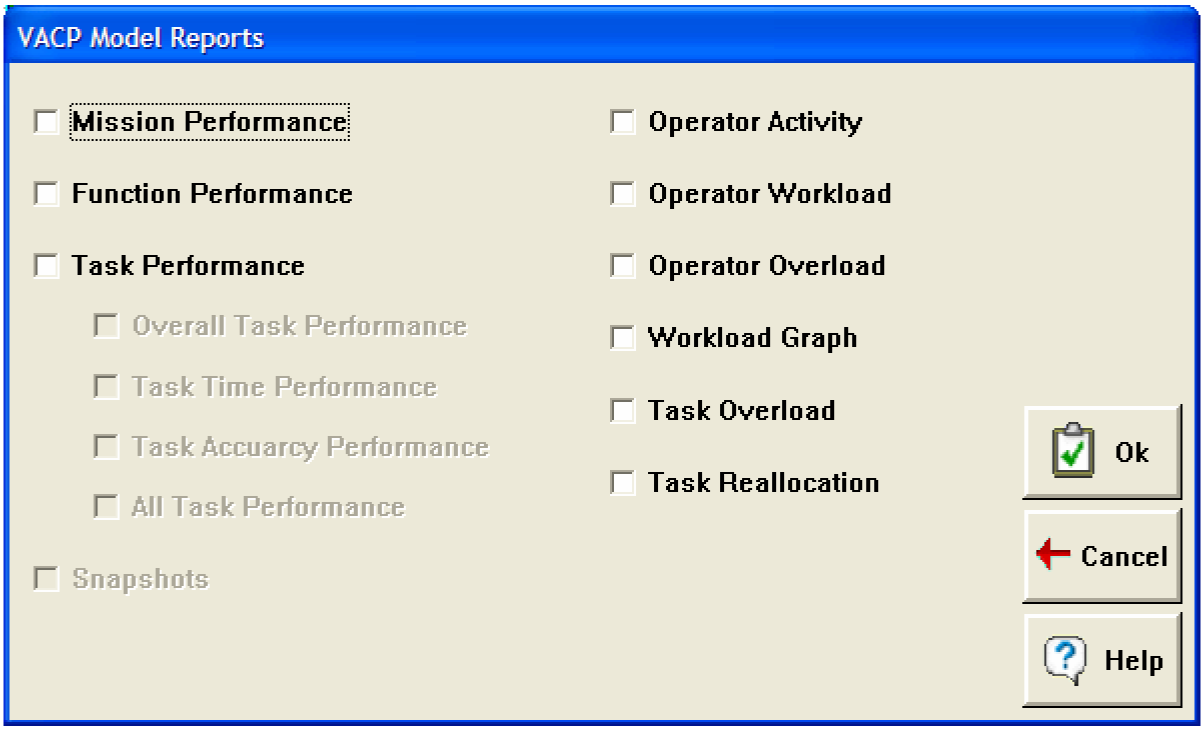


Figure 3-55. VACP Report Dialog

Next, Excel is launched, and all selected reports appear in a workbook format. Select the report you wish to view by clicking on the corresponding tab at the bottom of the workbook.

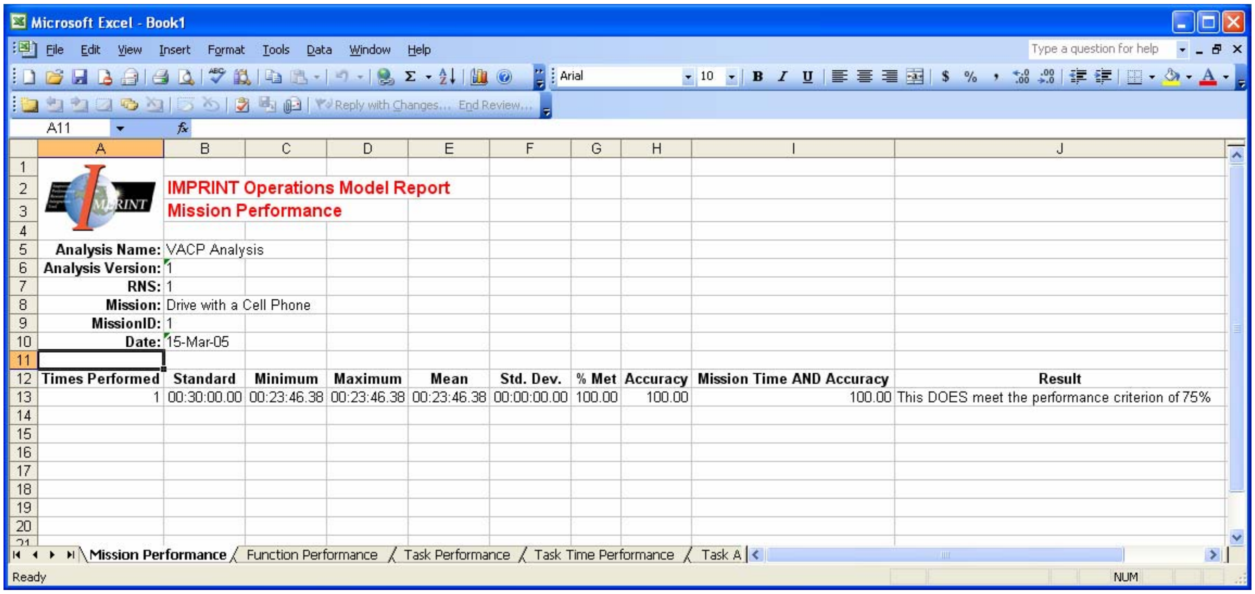


Figure 3-56. Operations Model Reports

Mission Performance Report

The Mission Performance Report provides information on how the Achieved Mission Time, the performance time that was simulated in a run, compares with the Mission Time Standard set by the user.

The report starts by displaying the number of times the mission was performed and the Time Standard you chose for the mission. The Time Standard is the slowest performance time that can be tolerated and have the mission still be considered a success. When IMPRINT executes your mission model, the performance time that is predicted by aggregating your individual tasks will be compared to this standard to ensure that your design can meet the mission level time standard.

The next four columns display the minimum, maximum, mean and standard deviation of the mission performance times. The proportion of times the Achieved Time meets the Mission Time Standard displays under the column % Met. The accuracy with which the mission completed displays in the Accuracy column. And the percentage of time in which both Mission Time Standard and Accuracy are met in the same occurrence displays in the Mission Time and Accuracy column.

The last column in this report shows the overall results of the mission simulation. If the proportion of times that the mission met the time and accuracy standard meets or exceeds the total mission criterion that you set, then the message will say that the mission does meet the performance criterion. If the proportion is less than the mission criterion, then the message will say the mission failed.

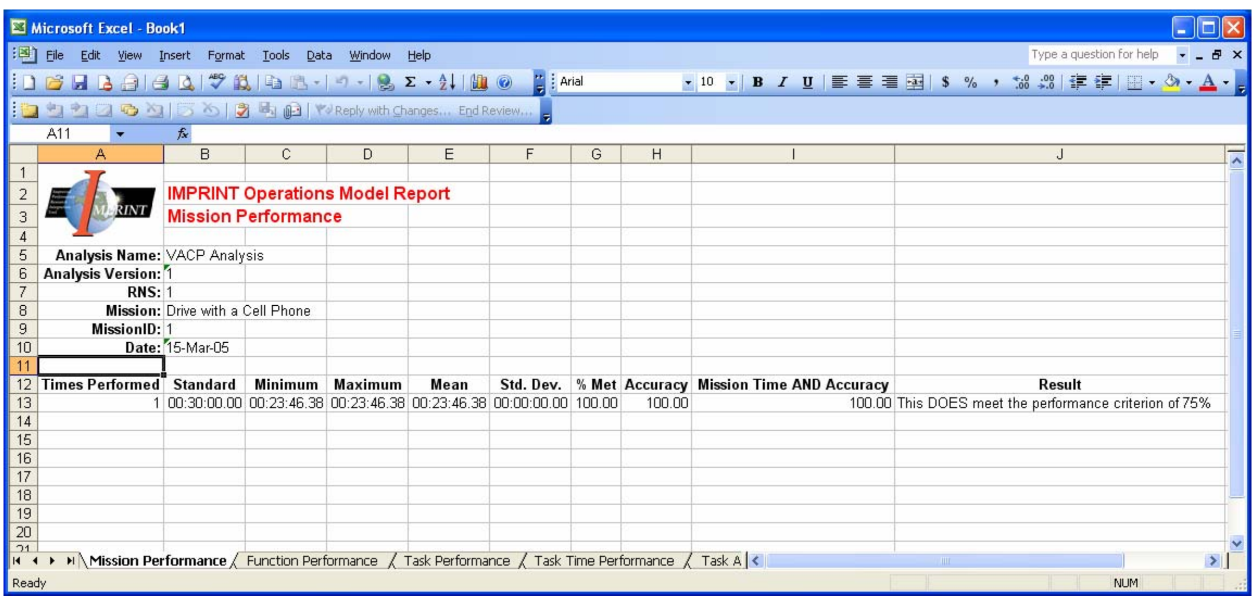


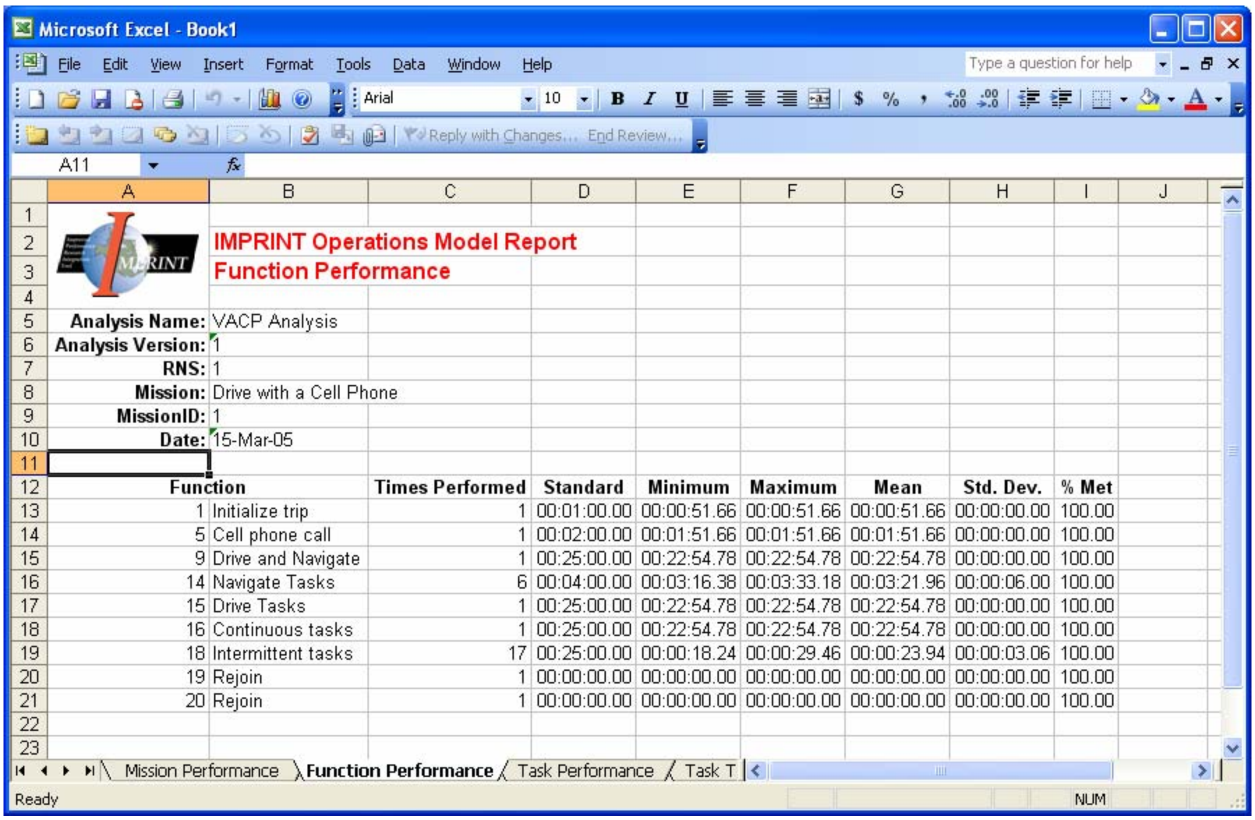
Figure 3-57. Mission Performance Report

Function Performance Report

The Function Performance Report includes a list of all functions performed, the number of times each function was performed, and the minimum, maximum, mean and standard deviation of the performance times.

This report also indicates the Function Performance Time Standard. The Time Standard is the slowest performance time that can be tolerated and have the function still be considered a success. When IMPRINT executes your mission model, the performance time that is predicted by the aggregation of all tasks in this function will be compared to this standard to ensure that your design can meet the function level time standard.

If you did not enter a time standard, it will default to zero. Therefore, it will probably cause the percentage of time you met the standard to be 0%.



IMPRINT Operations Model Report
Function Performance

Analysis Name: VACP Analysis
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 15-Mar-05

Function		Times Performed	Standard	Minimum	Maximum	Mean	Std. Dev.	% Met
1	Initialize trip	1	00:01:00.00	00:00:51.66	00:00:51.66	00:00:51.66	00:00:00.00	100.00
5	Cell phone call	1	00:02:00.00	00:01:51.66	00:01:51.66	00:01:51.66	00:00:00.00	100.00
9	Drive and Navigate	1	00:25:00.00	00:22:54.78	00:22:54.78	00:22:54.78	00:00:00.00	100.00
14	Navigate Tasks	6	00:04:00.00	00:03:16.38	00:03:33.18	00:03:21.96	00:00:06.00	100.00
15	Drive Tasks	1	00:25:00.00	00:22:54.78	00:22:54.78	00:22:54.78	00:00:00.00	100.00
16	Continuous tasks	1	00:25:00.00	00:22:54.78	00:22:54.78	00:22:54.78	00:00:00.00	100.00
18	Intermittent tasks	17	00:25:00.00	00:00:18.24	00:00:29.46	00:00:23.94	00:00:03.06	100.00
19	Rejoin	1	00:00:00.00	00:00:00.00	00:00:00.00	00:00:00.00	00:00:00.00	100.00
20	Rejoin	1	00:00:00.00	00:00:00.00	00:00:00.00	00:00:00.00	00:00:00.00	100.00

Figure 3-58. Function Performance Report

Task Performance Report

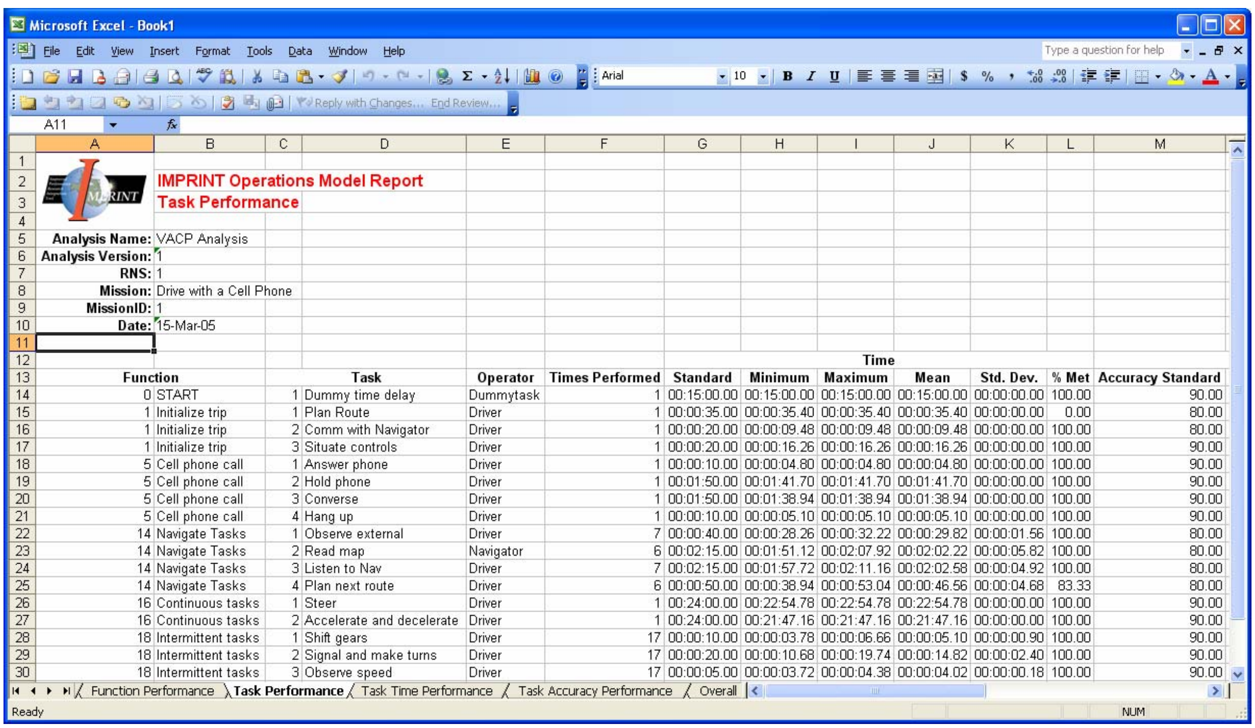
The Task Performance Report is a detailed report that provides output for each task in your mission model. Each listing starts by displaying a task's parent function, the task name itself, the operator performing the task and the number of times this task occurs.

The next column shows the Time Standard that the user set for this task. The Time Standard is the slowest performance time that can be tolerated and have the task still be considered a success.

The next four columns display the Minimum, Maximum, Mean and Standard Deviation of the task time. These are calculated from the simulation execution.

This report also includes a summary of the performance accuracy that was predicted for each task. The first column in this section is the Accuracy Standard for the task as set by the user. Next are the columns for the Accuracy measure (e.g., "mils from desired") and percentages of time the task met the criterion for Task Time, the Task Accuracy and the Task Time and Task Accuracy together.

The last two columns in this report display the percentage of time in which the task led to mission failure and whether or not the task met the performance criterion. If the task performance time is less than or equal to the task time standard, you will also see a message that says the task does meet the performance criterion. If the task performance time exceeds the task time standard, then you will see a message that the task did not meet the performance criterion. If you did not enter a time standard, it will default to zero. Therefore, it will probably cause the percentage of time in which you met the standard to be 0%.



IMPRINT Operations Model Report
Task Performance

Analysis Name: VACP Analysis
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 15-Mar-05

Function		Task		Operator	Times Performed	Time Standard	Time Minimum	Time Maximum	Time Mean	Time Std. Dev.	Time % Met	Accuracy Standard
0	START	1	Dummy time delay	Dummytask	1	00:15:00.00	00:15:00.00	00:15:00.00	00:15:00.00	00:00:00.00	100.00	90.00
1	Initialize trip	1	Plan Route	Driver	1	00:00:35.00	00:00:35.40	00:00:35.40	00:00:35.40	00:00:00.00	0.00	80.00
1	Initialize trip	2	Comm with Navigator	Driver	1	00:00:20.00	00:00:09.48	00:00:09.48	00:00:09.48	00:00:00.00	100.00	80.00
1	Initialize trip	3	Situate controls	Driver	1	00:00:20.00	00:00:16.26	00:00:16.26	00:00:16.26	00:00:00.00	100.00	90.00
5	Cell phone call	1	Answer phone	Driver	1	00:00:10.00	00:00:04.80	00:00:04.80	00:00:04.80	00:00:00.00	100.00	90.00
5	Cell phone call	2	Hold phone	Driver	1	00:01:50.00	00:01:41.70	00:01:41.70	00:01:41.70	00:00:00.00	100.00	90.00
5	Cell phone call	3	Converse	Driver	1	00:01:50.00	00:01:38.94	00:01:38.94	00:01:38.94	00:00:00.00	100.00	90.00
5	Cell phone call	4	Hang up	Driver	1	00:00:10.00	00:00:05.10	00:00:05.10	00:00:05.10	00:00:00.00	100.00	90.00
14	Navigate Tasks	1	Observe external	Driver	7	00:00:40.00	00:00:28.26	00:00:32.22	00:00:29.82	00:00:01.56	100.00	80.00
14	Navigate Tasks	2	Read map	Navigator	6	00:02:15.00	00:01:51.12	00:02:07.92	00:02:02.22	00:00:05.82	100.00	80.00
14	Navigate Tasks	3	Listen to Nav	Driver	7	00:02:15.00	00:01:57.72	00:02:11.16	00:02:02.58	00:00:04.92	100.00	80.00
14	Navigate Tasks	4	Plan next route	Driver	6	00:00:50.00	00:00:38.94	00:00:53.04	00:00:46.56	00:00:04.68	83.33	80.00
16	Continuous tasks	1	Steer	Driver	1	00:24:00.00	00:22:54.78	00:22:54.78	00:22:54.78	00:00:00.00	100.00	90.00
16	Continuous tasks	2	Accelerate and decelerate	Driver	1	00:24:00.00	00:21:47.16	00:21:47.16	00:21:47.16	00:00:00.00	100.00	90.00
18	Intermittent tasks	1	Shift gears	Driver	17	00:00:10.00	00:00:03.78	00:00:06.66	00:00:05.10	00:00:00.90	100.00	90.00
18	Intermittent tasks	2	Signal and make turns	Driver	17	00:00:20.00	00:00:10.68	00:00:19.74	00:00:14.82	00:00:02.40	100.00	90.00
18	Intermittent tasks	3	Observe speed	Driver	17	00:00:05.00	00:00:03.72	00:00:04.38	00:00:04.02	00:00:00.18	100.00	90.00

Figure 3-59. Task Performance Report

Task Time Performance Report

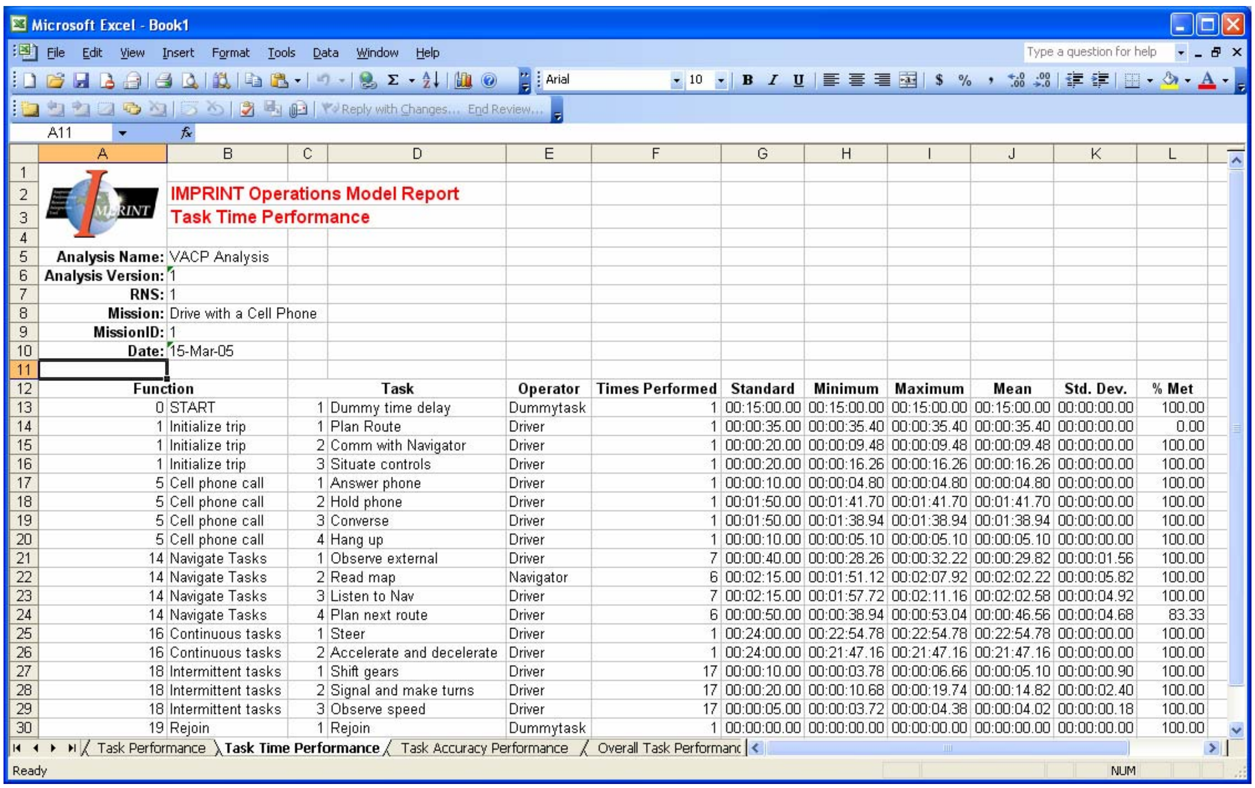
The Task Time Performance Report is a subset of the Task Performance Report which focuses on the performance times of all tasks.

Each listing starts by displaying a task's parent function, the task name itself, the operator performing the task and the number of times this task occurs.

The next column shows the Time Standard that the user set for this task. The Time Standard is the slowest performance time that can be tolerated and have the task still be considered a success.

The next four columns display the Minimum, Maximum, Mean and Standard Deviation of the task time. These are calculated from the simulation execution.

The last column in this report displays the percentage of time in which the task met the performance criterion. If you did not enter a time standard, it will default to zero. Therefore, it will probably cause the percentage of time in which you met the standard to be 0%.



IMPRINT Operations Model Report
Task Time Performance

Analysis Name: VACP Analysis
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 15-Mar-05

Function		Task		Operator	Times Performed	Standard	Minimum	Maximum	Mean	Std. Dev.	% Met
0	START	1	Dummy time delay	Dummytask	1	00:15:00.00	00:15:00.00	00:15:00.00	00:15:00.00	00:00:00.00	100.00
1	Initialize trip	1	Plan Route	Driver	1	00:00:35.00	00:00:35.40	00:00:35.40	00:00:35.40	00:00:00.00	0.00
1	Initialize trip	2	Comm with Navigator	Driver	1	00:00:20.00	00:00:09.48	00:00:09.48	00:00:09.48	00:00:00.00	100.00
1	Initialize trip	3	Situate controls	Driver	1	00:00:20.00	00:00:16.26	00:00:16.26	00:00:16.26	00:00:00.00	100.00
5	Cell phone call	1	Answer phone	Driver	1	00:00:10.00	00:00:04.80	00:00:04.80	00:00:04.80	00:00:00.00	100.00
5	Cell phone call	2	Hold phone	Driver	1	00:01:50.00	00:01:41.70	00:01:41.70	00:01:41.70	00:00:00.00	100.00
5	Cell phone call	3	Converse	Driver	1	00:01:50.00	00:01:38.94	00:01:38.94	00:01:38.94	00:00:00.00	100.00
5	Cell phone call	4	Hang up	Driver	1	00:00:10.00	00:00:05.10	00:00:05.10	00:00:05.10	00:00:00.00	100.00
14	Navigate Tasks	1	Observe external	Driver	7	00:00:40.00	00:00:28.26	00:00:32.22	00:00:29.82	00:00:01.56	100.00
14	Navigate Tasks	2	Read map	Navigator	6	00:02:15.00	00:01:51.12	00:02:07.92	00:02:02.22	00:00:05.82	100.00
14	Navigate Tasks	3	Listen to Nav	Driver	7	00:02:15.00	00:01:57.72	00:02:11.16	00:02:02.58	00:00:04.92	100.00
14	Navigate Tasks	4	Plan next route	Driver	6	00:00:50.00	00:00:38.94	00:00:53.04	00:00:46.56	00:00:04.68	83.33
16	Continuous tasks	1	Steer	Driver	1	00:24:00.00	00:22:54.78	00:22:54.78	00:22:54.78	00:00:00.00	100.00
16	Continuous tasks	2	Accelerate and decelerate	Driver	1	00:24:00.00	00:21:47.16	00:21:47.16	00:21:47.16	00:00:00.00	100.00
18	Intermittent tasks	1	Shift gears	Driver	17	00:00:10.00	00:00:03.78	00:00:06.66	00:00:05.10	00:00:00.90	100.00
18	Intermittent tasks	2	Signal and make turns	Driver	17	00:00:20.00	00:00:10.68	00:00:19.74	00:00:14.82	00:00:02.40	100.00
18	Intermittent tasks	3	Observe speed	Driver	17	00:00:05.00	00:00:03.72	00:00:04.38	00:00:04.02	00:00:00.18	100.00
19	Rejoin	1	Rejoin	Dummytask	1	00:00:00.00	00:00:00.00	00:00:00.00	00:00:00.00	00:00:00.00	100.00

Figure 3-60. Task Time Performance Report

Task Accuracy Performance Report

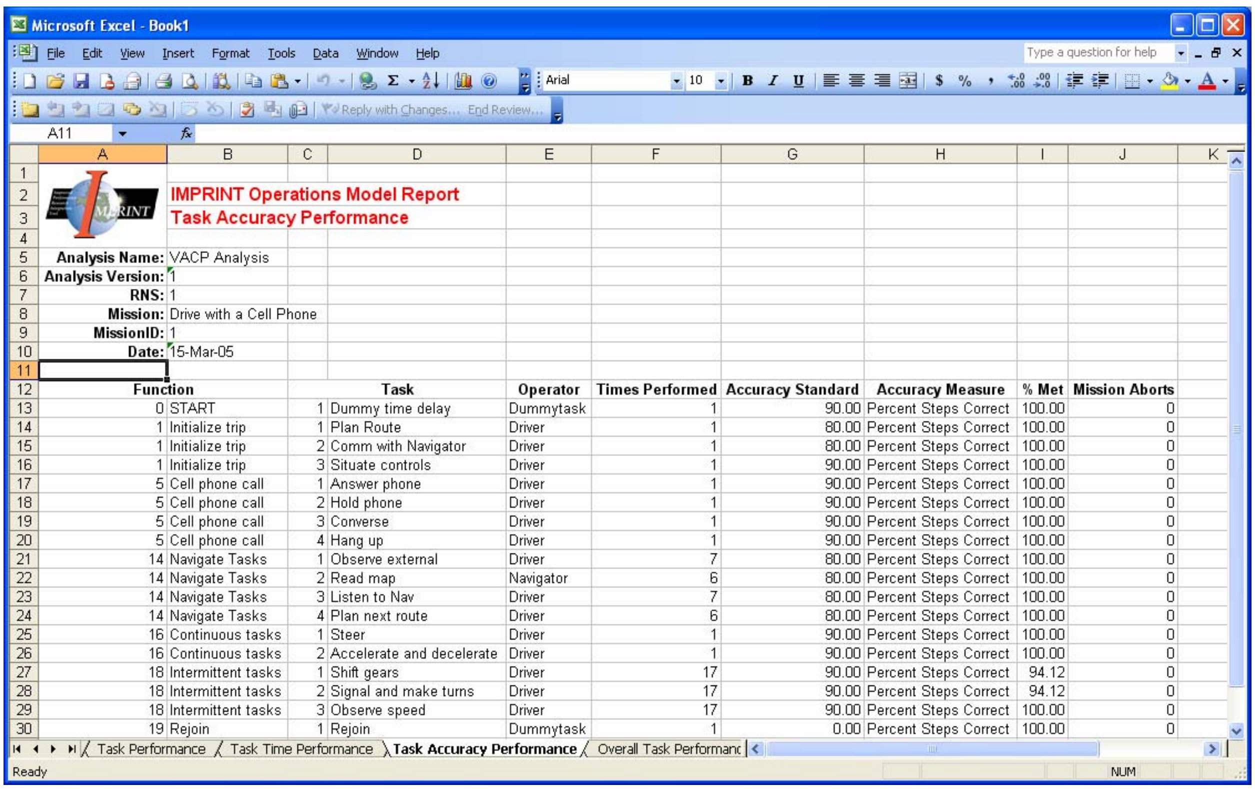
The Task Accuracy Performance Report is a subset of the Task Performance Report which focuses on the performance accuracy of all tasks.

Each listing starts by displaying a task's parent function, the task name itself, the operator performing the task and the number of times this task occurs.

This report also includes a summary of the performance accuracy that was predicted for each task. The first column in this section is the Accuracy Standard for the task as set by the user. Next are the columns for the Accuracy measure (e.g., "mils from desired") and percentages of time the task met the criterion for Task Time.

The next column in this report displays the percentage of time in which the task met the performance criterion. If you did not enter a time standard, it will default to zero. Therefore, it will probably cause the percentage of time in which you met the standard to be 0%.

The final column lists the number of times the performed task led to the mission aborting.



IMPRINT Operations Model Report
Task Accuracy Performance

Analysis Name: VACP Analysis
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 15-Mar-05

Function			Task	Operator	Times Performed	Accuracy Standard	Accuracy Measure	% Met	Mission Aborts
0	START	1	Dummy time delay	Dummytask	1	90.00	Percent Steps Correct	100.00	0
1	Initialize trip	1	Plan Route	Driver	1	80.00	Percent Steps Correct	100.00	0
1	Initialize trip	2	Comm with Navigator	Driver	1	80.00	Percent Steps Correct	100.00	0
1	Initialize trip	3	Situate controls	Driver	1	90.00	Percent Steps Correct	100.00	0
5	Cell phone call	1	Answer phone	Driver	1	90.00	Percent Steps Correct	100.00	0
5	Cell phone call	2	Hold phone	Driver	1	90.00	Percent Steps Correct	100.00	0
5	Cell phone call	3	Converse	Driver	1	90.00	Percent Steps Correct	100.00	0
5	Cell phone call	4	Hang up	Driver	1	90.00	Percent Steps Correct	100.00	0
14	Navigate Tasks	1	Observe external	Driver	7	80.00	Percent Steps Correct	100.00	0
14	Navigate Tasks	2	Read map	Navigator	6	80.00	Percent Steps Correct	100.00	0
14	Navigate Tasks	3	Listen to Nav	Driver	7	80.00	Percent Steps Correct	100.00	0
14	Navigate Tasks	4	Plan next route	Driver	6	80.00	Percent Steps Correct	100.00	0
16	Continuous tasks	1	Steer	Driver	1	90.00	Percent Steps Correct	100.00	0
16	Continuous tasks	2	Accelerate and decelerate	Driver	1	90.00	Percent Steps Correct	100.00	0
18	Intermittent tasks	1	Shift gears	Driver	17	90.00	Percent Steps Correct	94.12	0
18	Intermittent tasks	2	Signal and make turns	Driver	17	90.00	Percent Steps Correct	94.12	0
18	Intermittent tasks	3	Observe speed	Driver	17	90.00	Percent Steps Correct	100.00	0
19	Rejoin	1	Rejoin	Dummytask	1	0.00	Percent Steps Correct	100.00	0

Figure 3-61. Task Accuracy Performance Report

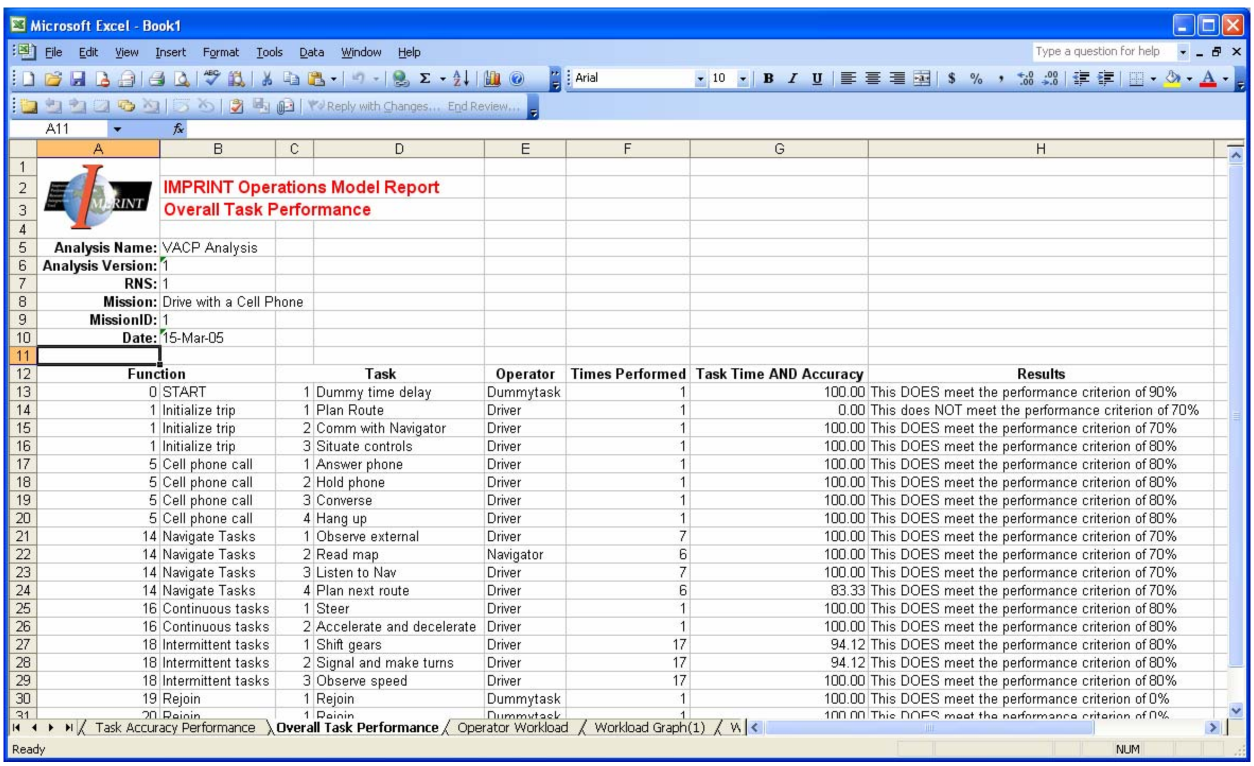
Overall Task Performance Report

The Overall Task Time Performance Report is a subset of the Task Performance Report which focuses on whether or not performance criterion (time and accuracy) were met.

Each listing starts by displaying a task's parent function, the task name itself, the operator performing the task and the number of times this task occurs.

This report also includes a summary of the percentages of time the task met the criterion for Task Time and Task Accuracy together.

The last column in this report displays a message declaring whether or not the task met the performance criterion. If the task performance time is less than or equal to the task time standard, you will also see a message that says the task does meet the performance criterion. If the task performance time exceeds the task time standard, then you will see a message that the task did not meet the performance criterion. If you did not enter a time standard, it will default to zero. Therefore, it will probably cause the percentage of time in which you met the standard to be 0%.



IMPRINT Operations Model Report
Overall Task Performance

Analysis Name: VACP Analysis
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 15-Mar-05

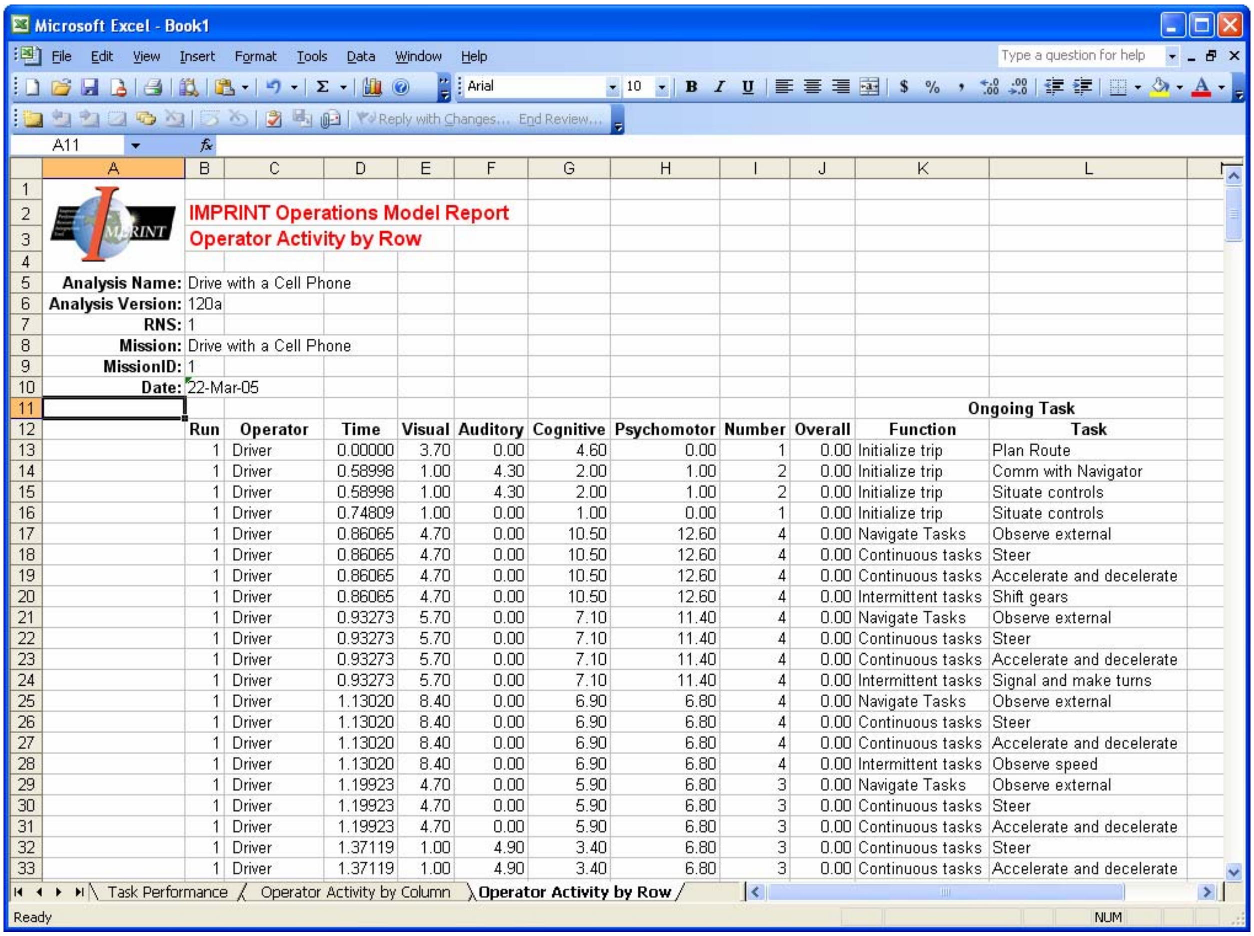
Function		Task		Operator	Times Performed	Task Time AND Accuracy	Results
0	START	1	Dummy time delay	Dummytask	1	100.00	This DOES meet the performance criterion of 90%
1	Initialize trip	1	Plan Route	Driver	1	0.00	This does NOT meet the performance criterion of 70%
1	Initialize trip	2	Comm with Navigator	Driver	1	100.00	This DOES meet the performance criterion of 70%
1	Initialize trip	3	Situate controls	Driver	1	100.00	This DOES meet the performance criterion of 80%
5	Cell phone call	1	Answer phone	Driver	1	100.00	This DOES meet the performance criterion of 80%
5	Cell phone call	2	Hold phone	Driver	1	100.00	This DOES meet the performance criterion of 80%
5	Cell phone call	3	Converse	Driver	1	100.00	This DOES meet the performance criterion of 80%
5	Cell phone call	4	Hang up	Driver	1	100.00	This DOES meet the performance criterion of 80%
14	Navigate Tasks	1	Observe external	Driver	7	100.00	This DOES meet the performance criterion of 70%
14	Navigate Tasks	2	Read map	Navigator	6	100.00	This DOES meet the performance criterion of 70%
14	Navigate Tasks	3	Listen to Nav	Driver	7	100.00	This DOES meet the performance criterion of 70%
14	Navigate Tasks	4	Plan next route	Driver	6	83.33	This DOES meet the performance criterion of 70%
16	Continuous tasks	1	Steer	Driver	1	100.00	This DOES meet the performance criterion of 80%
16	Continuous tasks	2	Accelerate and decelerate	Driver	1	100.00	This DOES meet the performance criterion of 80%
18	Intermittent tasks	1	Shift gears	Driver	17	94.12	This DOES meet the performance criterion of 80%
18	Intermittent tasks	2	Signal and make turns	Driver	17	94.12	This DOES meet the performance criterion of 80%
18	Intermittent tasks	3	Observe speed	Driver	17	100.00	This DOES meet the performance criterion of 80%
19	Rejoin	1	Rejoin	Dummytask	1	100.00	This DOES meet the performance criterion of 0%
20	Rejoin	1	Rejoin	Dummytask	1	100.00	This DOES meet the performance criterion of 0%

Figure 3-62. Overall Task Performance Report

Operator Activity Report

The Operator Activity Report lists each occurrence of a function and/or task for all operators. Functions and tasks are listed in the order in which they occur, and the functions and tasks that occur simultaneously display the same value in the Time column.

This report also displays workload for each channel, the Overall workload and the number of ongoing tasks.



IMPRINT Operations Model Report
Operator Activity by Row

Analysis Name: Drive with a Cell Phone
Analysis Version: 120a
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 22-Mar-05

Run	Operator	Time	Visual	Auditory	Cognitive	Psychomotor	Number	Overall	Ongoing Task Function	Task
1	Driver	0.00000	3.70	0.00	4.60	0.00	1	0.00	Initialize trip	Plan Route
1	Driver	0.58998	1.00	4.30	2.00	1.00	2	0.00	Initialize trip	Comm with Navigator
1	Driver	0.58998	1.00	4.30	2.00	1.00	2	0.00	Initialize trip	Situate controls
1	Driver	0.74809	1.00	0.00	1.00	0.00	1	0.00	Initialize trip	Situate controls
1	Driver	0.86065	4.70	0.00	10.50	12.60	4	0.00	Navigate Tasks	Observe external
1	Driver	0.86065	4.70	0.00	10.50	12.60	4	0.00	Continuous tasks	Steer
1	Driver	0.86065	4.70	0.00	10.50	12.60	4	0.00	Continuous tasks	Accelerate and decelerate
1	Driver	0.86065	4.70	0.00	10.50	12.60	4	0.00	Intermittent tasks	Shift gears
1	Driver	0.93273	5.70	0.00	7.10	11.40	4	0.00	Navigate Tasks	Observe external
1	Driver	0.93273	5.70	0.00	7.10	11.40	4	0.00	Continuous tasks	Steer
1	Driver	0.93273	5.70	0.00	7.10	11.40	4	0.00	Continuous tasks	Accelerate and decelerate
1	Driver	0.93273	5.70	0.00	7.10	11.40	4	0.00	Intermittent tasks	Signal and make turns
1	Driver	1.13020	8.40	0.00	6.90	6.80	4	0.00	Navigate Tasks	Observe external
1	Driver	1.13020	8.40	0.00	6.90	6.80	4	0.00	Continuous tasks	Steer
1	Driver	1.13020	8.40	0.00	6.90	6.80	4	0.00	Continuous tasks	Accelerate and decelerate
1	Driver	1.13020	8.40	0.00	6.90	6.80	4	0.00	Intermittent tasks	Observe speed
1	Driver	1.19923	4.70	0.00	5.90	6.80	3	0.00	Navigate Tasks	Observe external
1	Driver	1.19923	4.70	0.00	5.90	6.80	3	0.00	Continuous tasks	Steer
1	Driver	1.19923	4.70	0.00	5.90	6.80	3	0.00	Continuous tasks	Accelerate and decelerate
1	Driver	1.37119	1.00	4.90	3.40	6.80	3	0.00	Continuous tasks	Steer
1	Driver	1.37119	1.00	4.90	3.40	6.80	3	0.00	Continuous tasks	Accelerate and decelerate

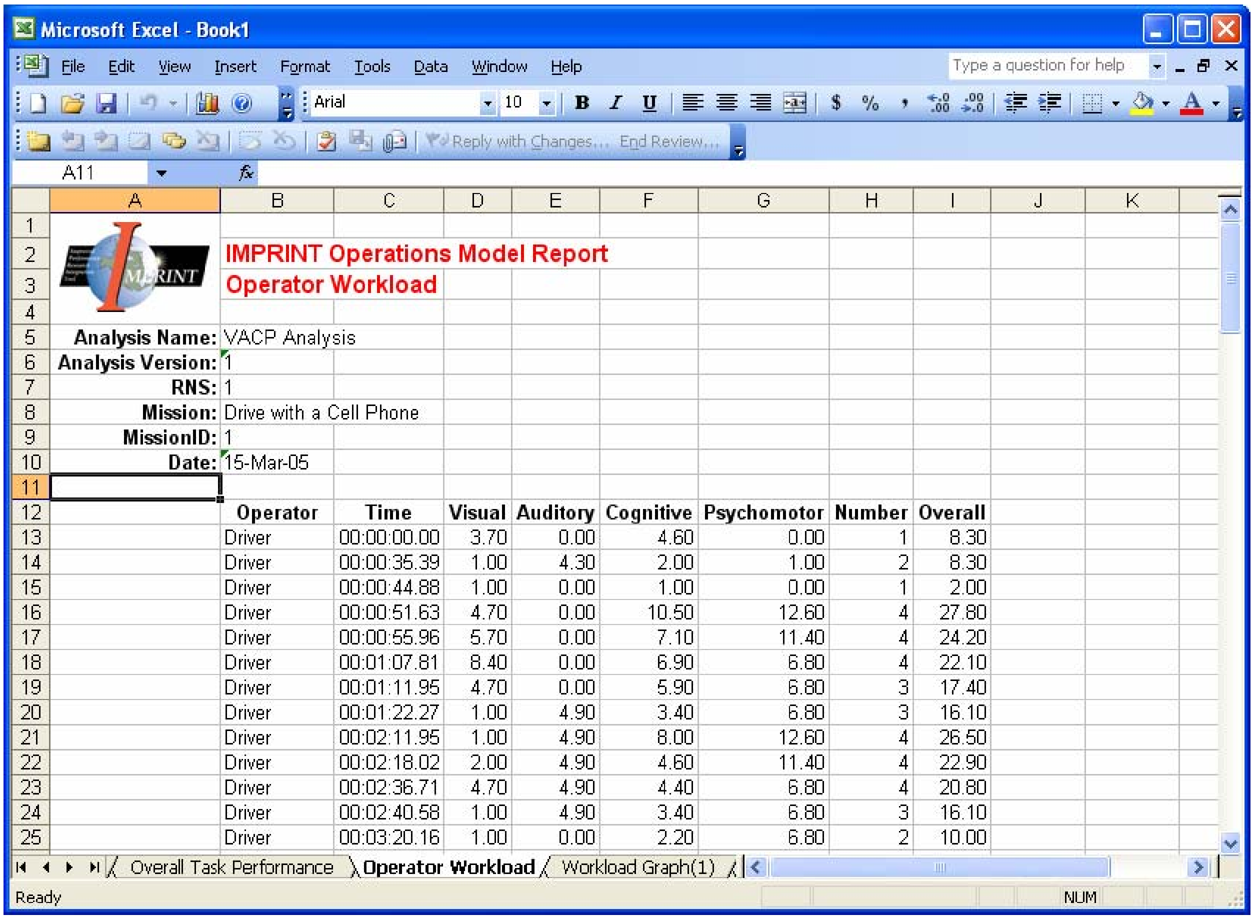
Figure 3-63. Operator Activity Report

Operator Workload Report – Workload Graph and Operator Workload Table

The Operator Workload Report includes a listing of each operator's workload throughout the mission timeline. Workload is broken down into different categories, i.e. Visual, Auditory, Cognitive and Psychomotor and Overall.) This report also shows the number of ongoing tasks at each moment reported.

The Operator Workload Table provides the workload profile for each operator in a tabular format. The Workload Graph displays the workload profiles on an x-y graph. You can use either form of this report to quickly identify points of high workload.

Check the option for the Operator Workload report from the initial Operational Results reports menu, and then click the OK button. You will then see the following report:



Microsoft Excel - Book1

IMPRINT Operations Model Report
Operator Workload

Analysis Name: VACP Analysis
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 15-Mar-05

Operator	Time	Visual	Auditory	Cognitive	Psychomotor	Number	Overall
Driver	00:00:00.00	3.70	0.00	4.60	0.00	1	8.30
Driver	00:00:35.39	1.00	4.30	2.00	1.00	2	8.30
Driver	00:00:44.88	1.00	0.00	1.00	0.00	1	2.00
Driver	00:00:51.63	4.70	0.00	10.50	12.60	4	27.80
Driver	00:00:55.96	5.70	0.00	7.10	11.40	4	24.20
Driver	00:01:07.81	8.40	0.00	6.90	6.80	4	22.10
Driver	00:01:11.95	4.70	0.00	5.90	6.80	3	17.40
Driver	00:01:22.27	1.00	4.90	3.40	6.80	3	16.10
Driver	00:02:11.95	1.00	4.90	8.00	12.60	4	26.50
Driver	00:02:18.02	2.00	4.90	4.60	11.40	4	22.90
Driver	00:02:36.71	4.70	4.90	4.40	6.80	4	20.80
Driver	00:02:40.58	1.00	4.90	3.40	6.80	3	16.10
Driver	00:03:20.16	1.00	0.00	2.20	6.80	2	10.00

Overall Task Performance / Operator Workload / Workload Graph(1)

Figure 3-64. Operator Workload Report

The report shows:

- Clock – the time at which this operator began experiencing this workload level
- operators 0 through 9

Alternatively, you can use the Workload Graph option to get a simple graphical report of operator workload.   A unique Workload graph displays for each designated operator.

To view the Operator Workload graph, you must first select the Workload Graph option from the initial Operational Results reports menu. You will then be prompted to check the boxes corresponding to the operators' data you wish to graph and to select Start Time and End Time for each. In the Operators field, you may choose one operator, multiple operators or all operators to be plotted on the same chart.

You will also be given the option to select certain modes of workload by checking the boxes for "Visual", 'Auditory", "Cognitive", "Psychomotor", "Overall" and the "Number of Tasks".

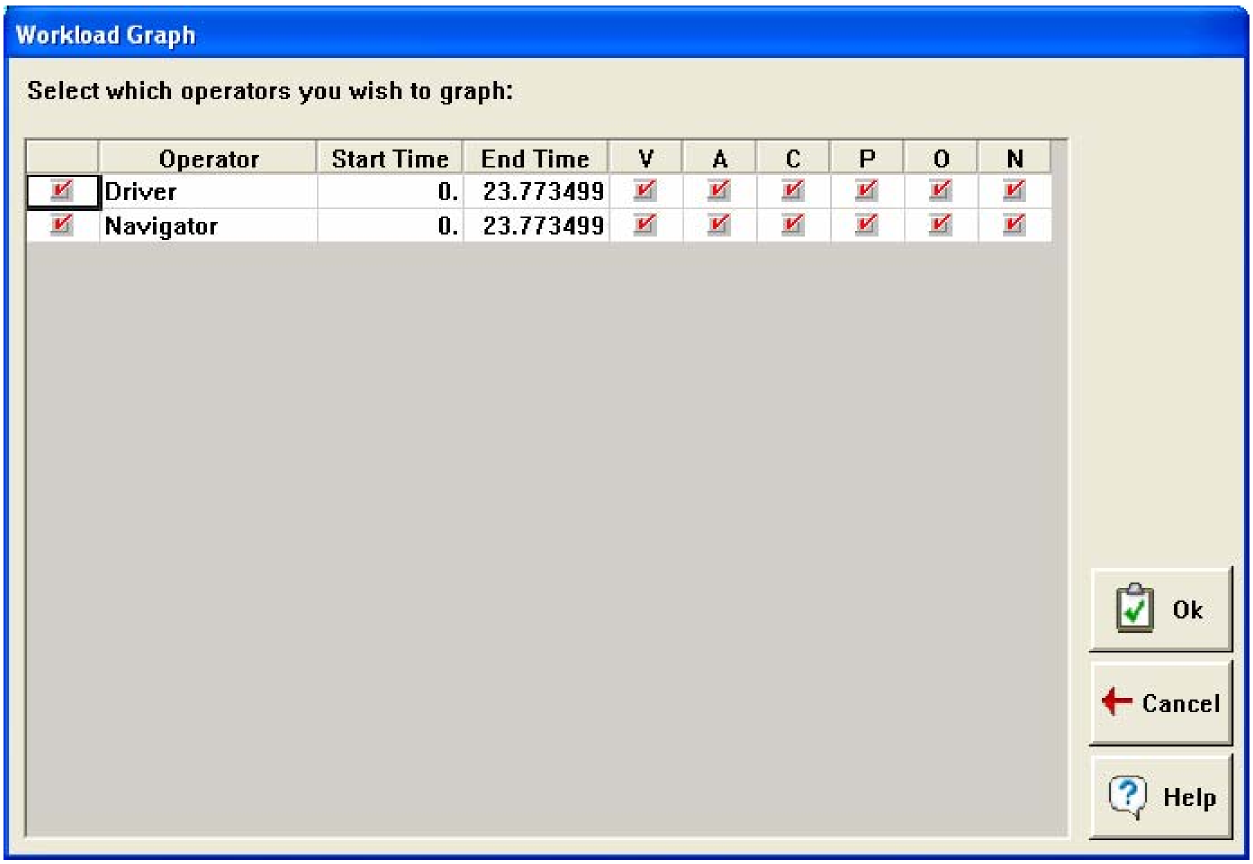


Figure 3-64. Workload Graph Dialog

Once you have entered data in the required fields, click the "OK" button. You will then see the following graph:

The workload is displayed as a step graph on an x-y axis. The x (horizontal) axis represents time and the y (vertical) axis represents the workload index. Each operator's workload profile is displayed in a different color. The key is located in the window.

The time scale ranges from time 0.00 seconds through mission completion time.

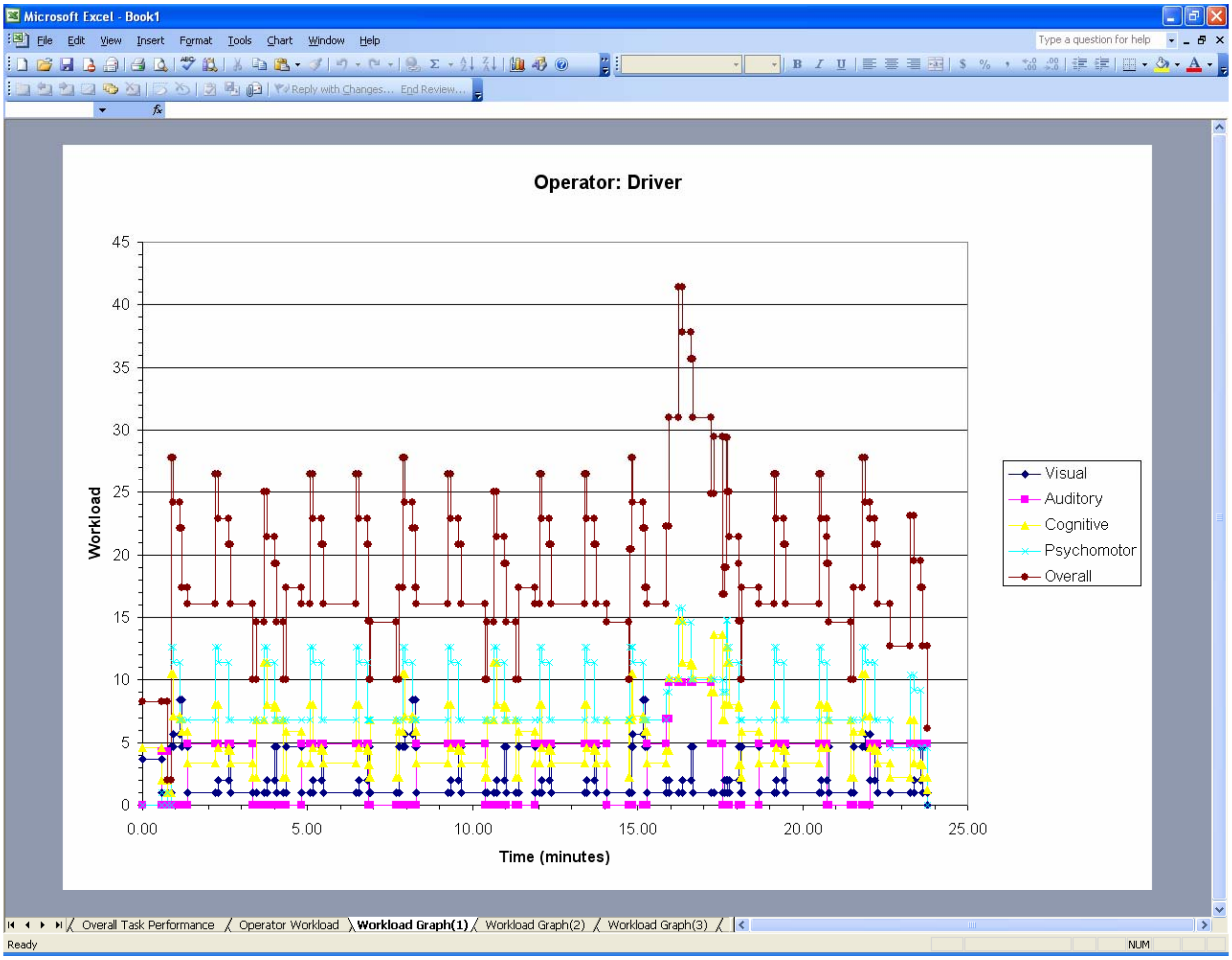


Figure 3-66. Operator Workload Graph

The final three reports are associated with reporting operator overload, if any occurred during your mission:

Operator Overload Report

As previously discussed in this user guide, IMPRINT uses High Workload Definitions to identify high workload levels for crew members. When a system mission model runs, the current workload levels of each operator are added across all tasks that the operator is performing. The sum is compared to each of the high workload definitions. Whenever an individual operator's workload exceeds the high workload definitions set by the user, this operator is considered to be in an **Overload** situation. The Operator Overload Report tells you the percentage of time each operator spent in an overload condition. This report also lists the number of overload points that exist for each operator.

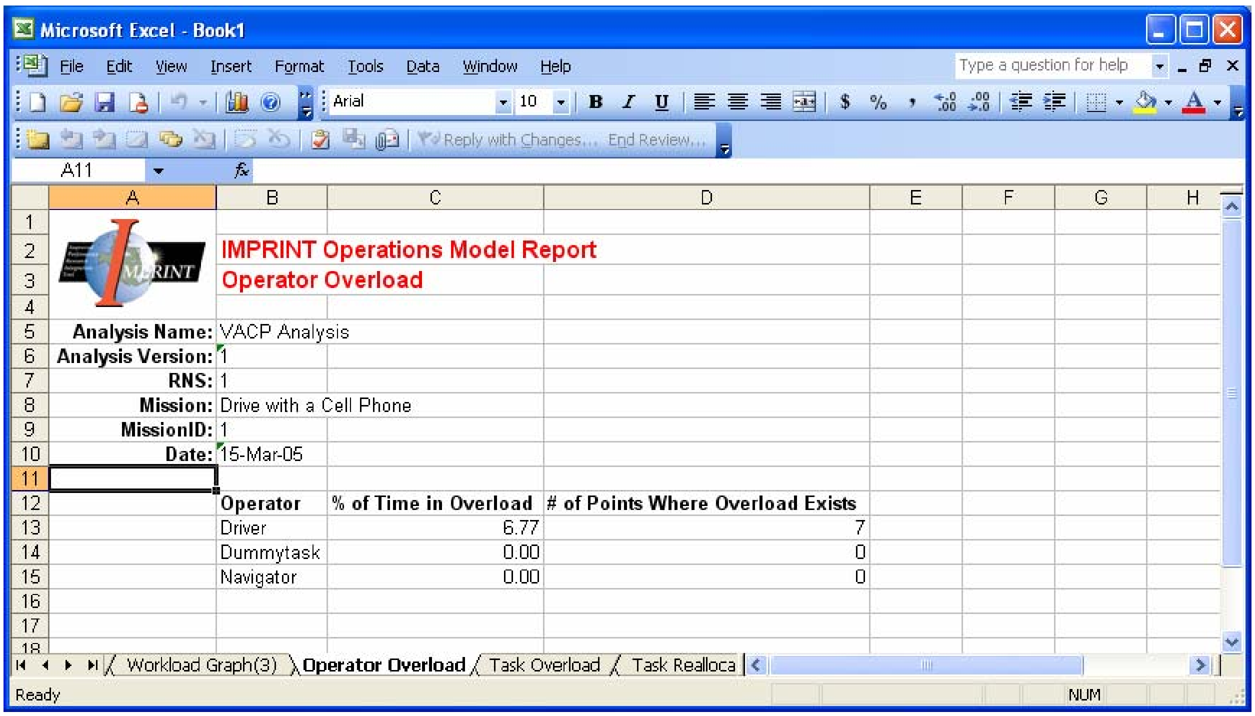


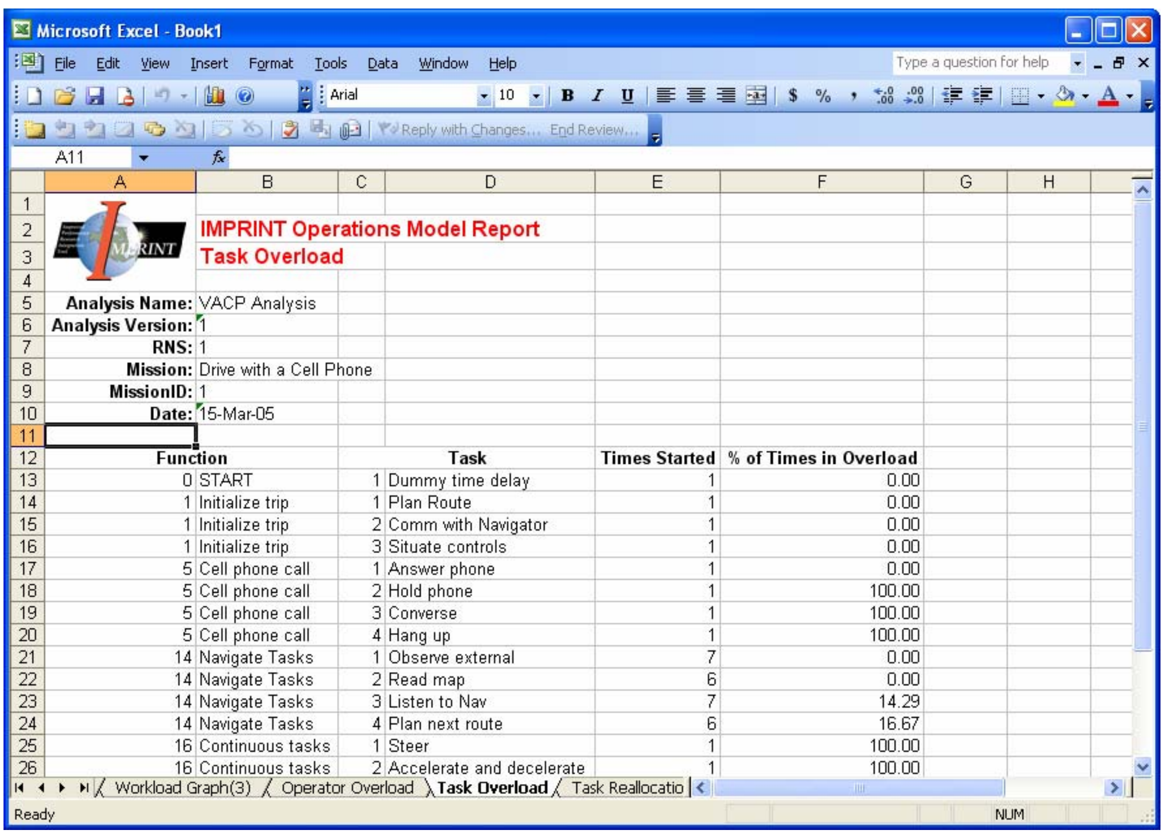
Figure 3-67. Operator Overload Report

Task Overload Report

The Task Overload Report provides a listing of all tasks included in the mission, and their respective parent functions. Alongside each task listing is a summary of the number of times the task began, and the percentage of time the task began in an overload condition. Note that if the task has a zero time duration (the task start time and end time is the same), then the task will be recorded as “started,” but it will never contribute to overload (since workload spikes of zero duration are not considered a real spike).

When it is obvious from the Task Overload report which tasks are leading to overload conditions, these tasks should be revisited in the network diagram in order that they can be reallocated to different operators in order to alleviate overload. To reassign one of the tasks, you must have first identified secondary operators for the selected tasks. If you have not identified secondary operators, IMPRINT will remind you of this. You can either attempt to reallocate a different task, or you can return to the define mission portion of IMPRINT and assign secondary operators.

After you have moved through all the points of overload, you must re-execute your mission and view the Task Overload report again to ensure that overloads have been alleviated. Additionally, it will be important that you change the random number seed and run it several more times to provide your tasks and opportunity to sample from the distribution of times, accuracies and branching logic. A different random number seed may actually trigger different overload points.


IMPRINT Operations Model Report
Task Overload

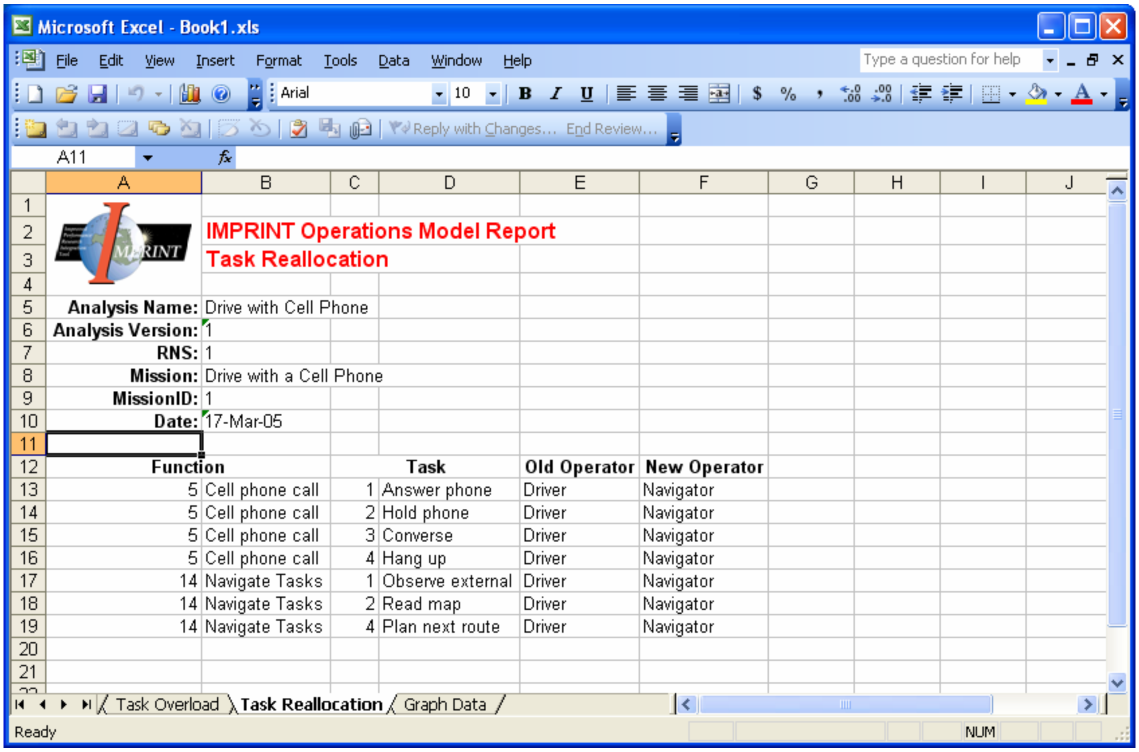
Analysis Name: VACP Analysis
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 15-Mar-05

Function		Task		Times Started	% of Times in Overload
0	START	1	Dummy time delay	1	0.00
1	Initialize trip	1	Plan Route	1	0.00
1	Initialize trip	2	Comm with Navigator	1	0.00
1	Initialize trip	3	Situate controls	1	0.00
5	Cell phone call	1	Answer phone	1	0.00
5	Cell phone call	2	Hold phone	1	100.00
5	Cell phone call	3	Converse	1	100.00
5	Cell phone call	4	Hang up	1	100.00
14	Navigate Tasks	1	Observe external	7	0.00
14	Navigate Tasks	2	Read map	6	0.00
14	Navigate Tasks	3	Listen to Nav	7	14.29
14	Navigate Tasks	4	Plan next route	6	16.67
16	Continuous tasks	1	Steer	1	100.00
16	Continuous tasks	2	Accelerate and decelerate	1	100.00

Figure 3-68. Task Overload Report

Task Reallocation Report

The Task Reallocation Report summarizes the result of any task reallocation. Task reallocation is the result of reassigning tasks that were performed during points of workload overload.



IMPRINT Operations Model Report
Task Reallocation

Analysis Name: Drive with Cell Phone
Analysis Version: 1
RNS: 1
Mission: Drive with a Cell Phone
MissionID: 1
Date: 17-Mar-05

Function		Task		Old Operator	New Operator
5	Cell phone call	1	Answer phone	Driver	Navigator
5	Cell phone call	2	Hold phone	Driver	Navigator
5	Cell phone call	3	Converse	Driver	Navigator
5	Cell phone call	4	Hang up	Driver	Navigator
14	Navigate Tasks	1	Observe external	Driver	Navigator
14	Navigate Tasks	2	Read map	Driver	Navigator
14	Navigate Tasks	4	Plan next route	Driver	Navigator

Figure 3-69. Task Reallocation Report

Note: in order to see results of task reallocation, follow the steps below:

1. Confirm that high workload definitions exist (see the High Workload Definitions option under the Options menu.)
2. Run your model.
3. Open up the Operations results report, and confirm you have actual cases of overload – this can be checked in the Task Overload report.
4. Define secondary operators for the applicable tasks.
5. Run the model once again.
6. Under the Adjust menu, go to the Workload Reassignment option and choose a reallocation method. Either auto or manual is Ok.
7. Without running the model again, run the reports. Confirm that data now shows up in the Task Reallocation report.

Graph Data Report

The Graph Data Report displays all data use to generate the Workload graphs. Note: the Graph Data report contains duplicate rows of data which are added for graphing purposes. These extra rows allow the data to be shown as a "step chart", an enhancement that enables the report to show workload over time.

For VACP models, the graph data shows a separate dataset for each operator thus an individual graph for each operator can be generated from this worksheet.

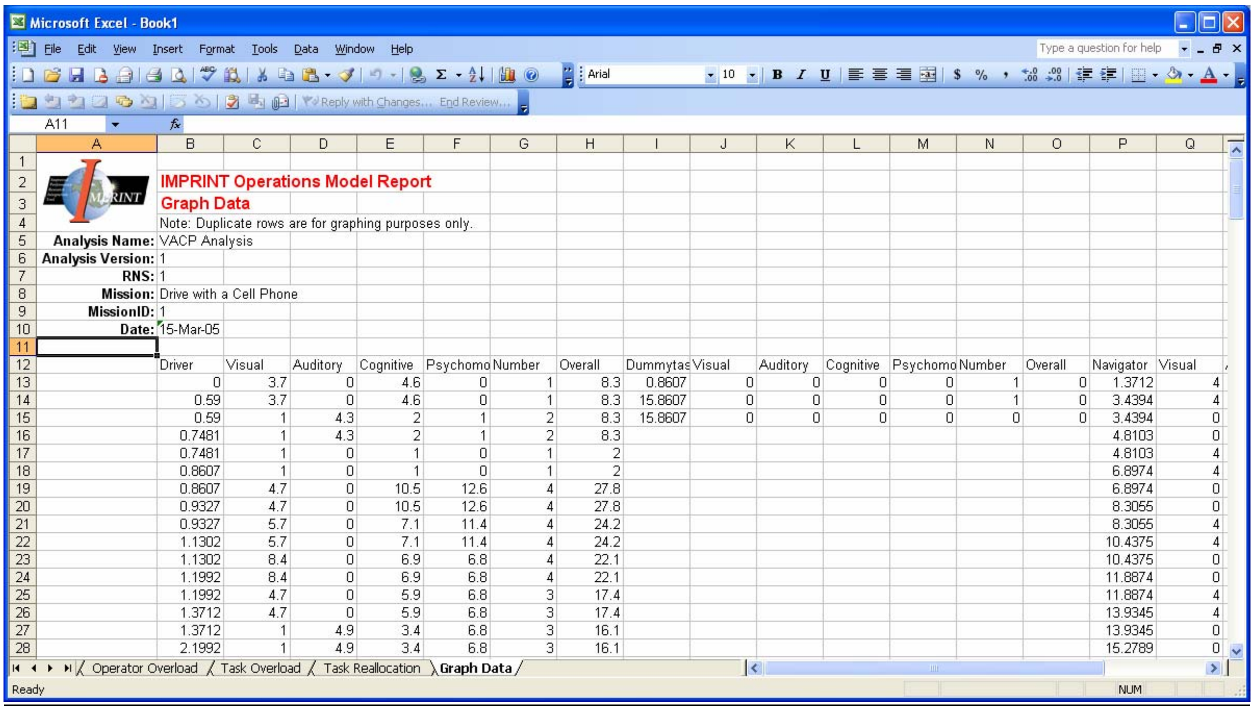


Figure 3-70. Graph Data Report

Maintenance Model Results

To create maintenance model reports, choose the “Maintenance Results...” option from the “Reports” menu. When you make this menu selection, two new dialogs will appear, prompting you to first select a Scenario from a drop-down menu and to then select the reports you wish to generate for that scenario.

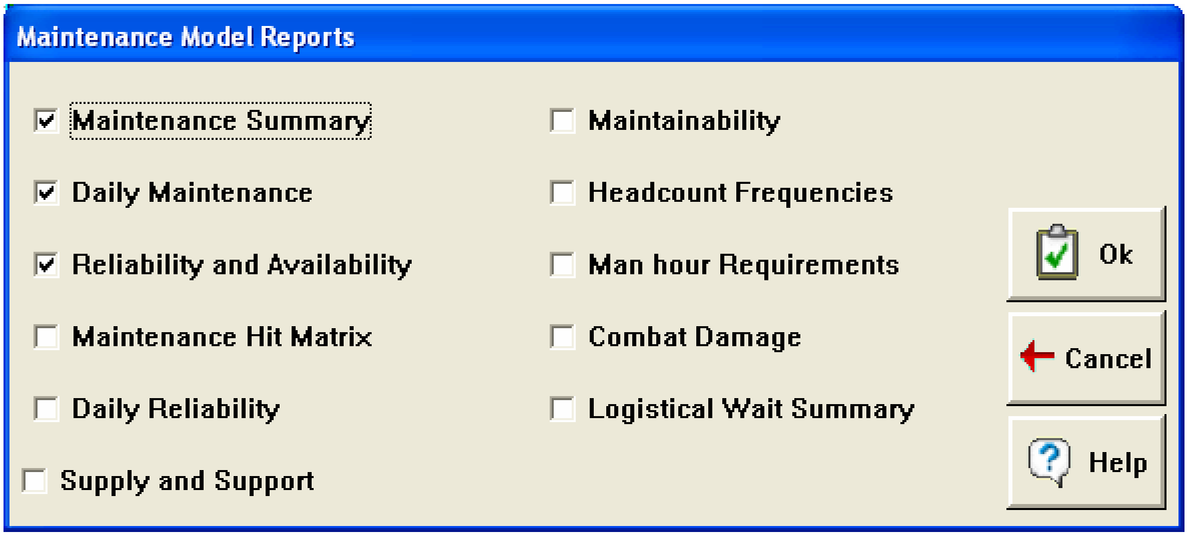


Figure 3-71. Maintenance Model Reports Dialog

Choose each report you wish to view by clicking its checkbox to the left.

Finally, clicking on the “Ok” button will generate and display the selected Scenario reports as shown in the figure below. IMPRINT uses Microsoft Excel to generate and display reports.

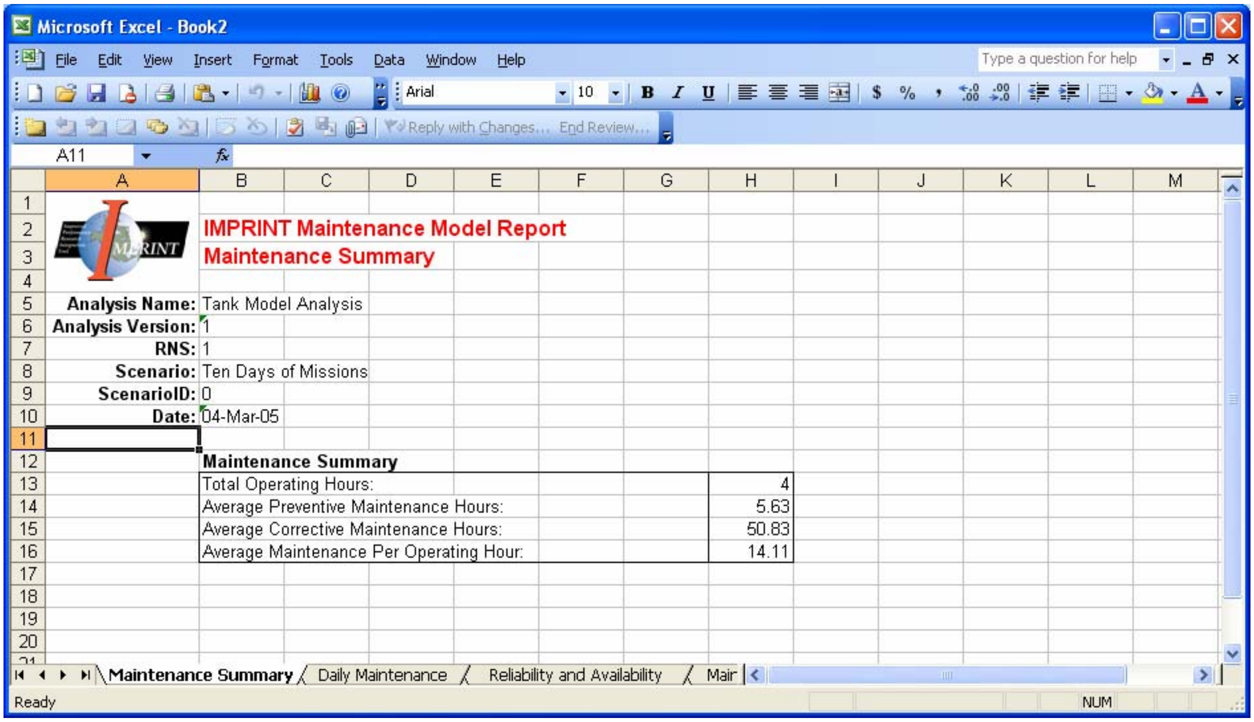


Figure 3-72. Maintenance Model Reports

Each of the individual reports described below are presented as separate tabs at the bottom of the Excel Workbook. To navigate between reports, click on the labeled tabs. For more information on using Microsoft Excel, please refer to the Microsoft Excel help feature.

Maintenance Summary Report

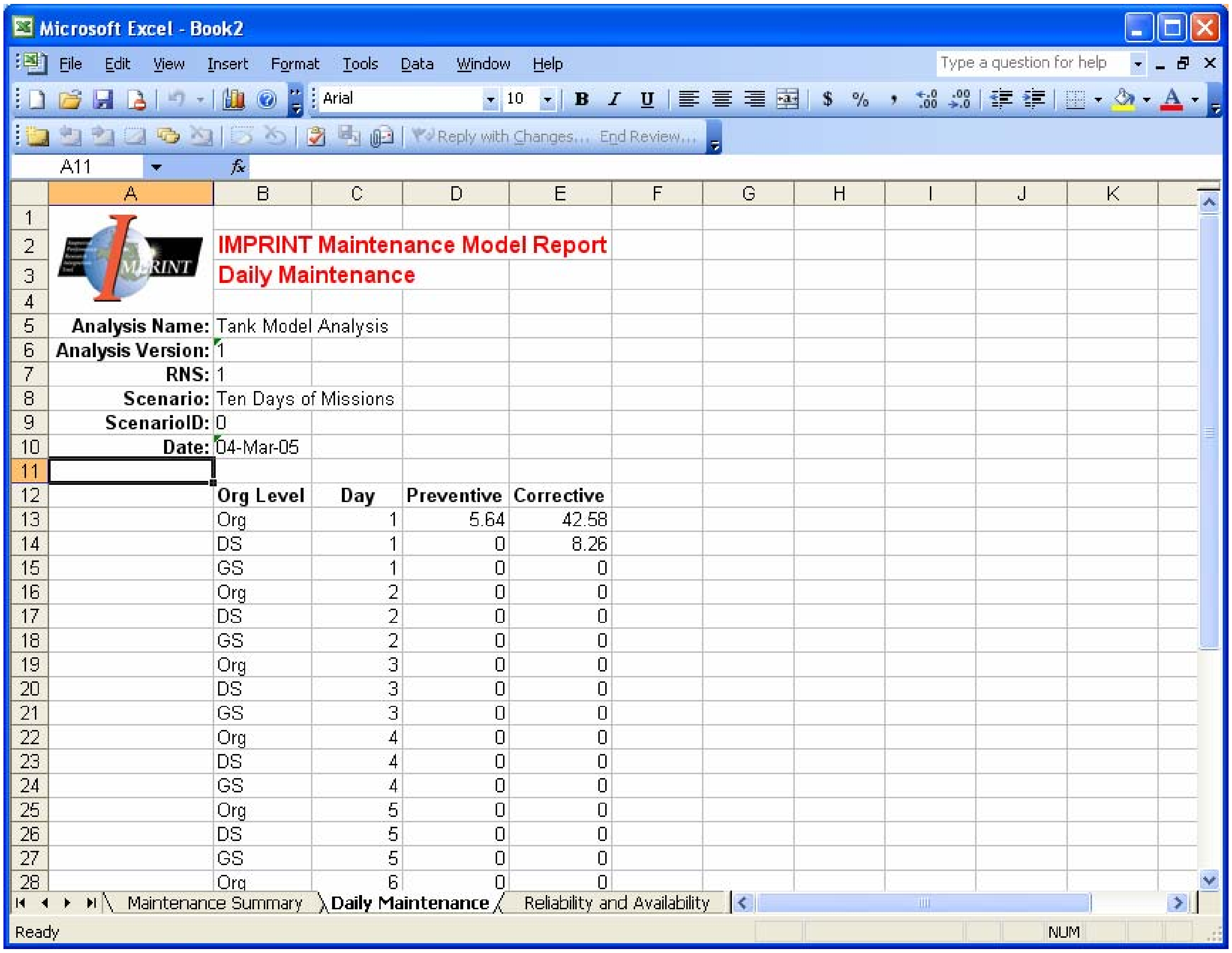
The maintenance summary report contains four data items that summarize the maintenance actions that were generated during the simulation:

- Total Operating Hours simulated
- Average Preventative Maintenance Hours - calculated by taking the total amount of man-hours in this category, and dividing it by the total number of systems in the scenario
- Average Corrective Maintenance Hours - calculated by taking the total amount of man-hours in this category, and dividing it by the total number of systems in the scenario
- Average Maintenance Per Operating Hour - the average maintenance man-hours simulated per operational hour, calculated by dividing the sum of the preventive and corrective maintenance man-hours by the total operating hours for all systems.

Daily Maintenance Report

This report contains the amount of maintenance man-hours that were simulated at all organizational level types (e.g., ORG, DS, GS) for both preventative maintenance and corrective maintenance.

The values in this report are totals across all systems.



IMPRINT Maintenance Model Report
Daily Maintenance

Analysis Name:	Tank Model Analysis
Analysis Version:	1
RNS:	1
Scenario:	Ten Days of Missions
ScenarioID:	0
Date:	04-Mar-05

Org Level	Day	Preventive	Corrective
Org	1	5.64	42.58
DS	1	0	8.26
GS	1	0	0
Org	2	0	0
DS	2	0	0
GS	2	0	0
Org	3	0	0
DS	3	0	0
GS	3	0	0
Org	4	0	0
DS	4	0	0
GS	4	0	0
Org	5	0	0
DS	5	0	0
GS	5	0	0
Org	6	0	0

Figure 3-73. Daily Maintenance Report

Reliability and Availability Report

This report has two parts. The first part is the Reliability Summary. It includes the number of segments requested and accomplished during the simulation. The report also includes measures for the number of times systems were requested, and the number of times that those system requests were accomplished. If you had one segment and a maximum of two systems assigned to that segment, then that will be reported as "Number of times Systems Requested" = 2. If only one of the systems actually performed the segment (because the other system was either busy or in maintenance), then that will be reported as "Number of Times System Requests Accomplished" = 1.

The second part of the screen includes an Availability Summary. The values are calculated as follows:

- Average inherent availability = ((scenario length in hours x # of systems) minus (total clock hours on corrective maintenance)) divided by (scenario length in hours x # of systems)

- Average achieved availability = ((scenario length in hours x # of systems) minus (total clock hours on corrective + preventive maintenance)) divided by (scenario length in hours x # of systems)

Note that inherent and achieved availability consider the total number of days simulated in hours (e.g., 365 * 24), minus the number of clock hours spent in maintenance. Therefore, if two or more soldiers are working at the same time on the same system, they are counted just once. Similarly, if two maintenance tasks are being worked on at the same time, it is only counted once.)

- Readiness = segments accomplished divided by segments requested

This report includes all segments that completed through the midnight of the last day of the simulation.

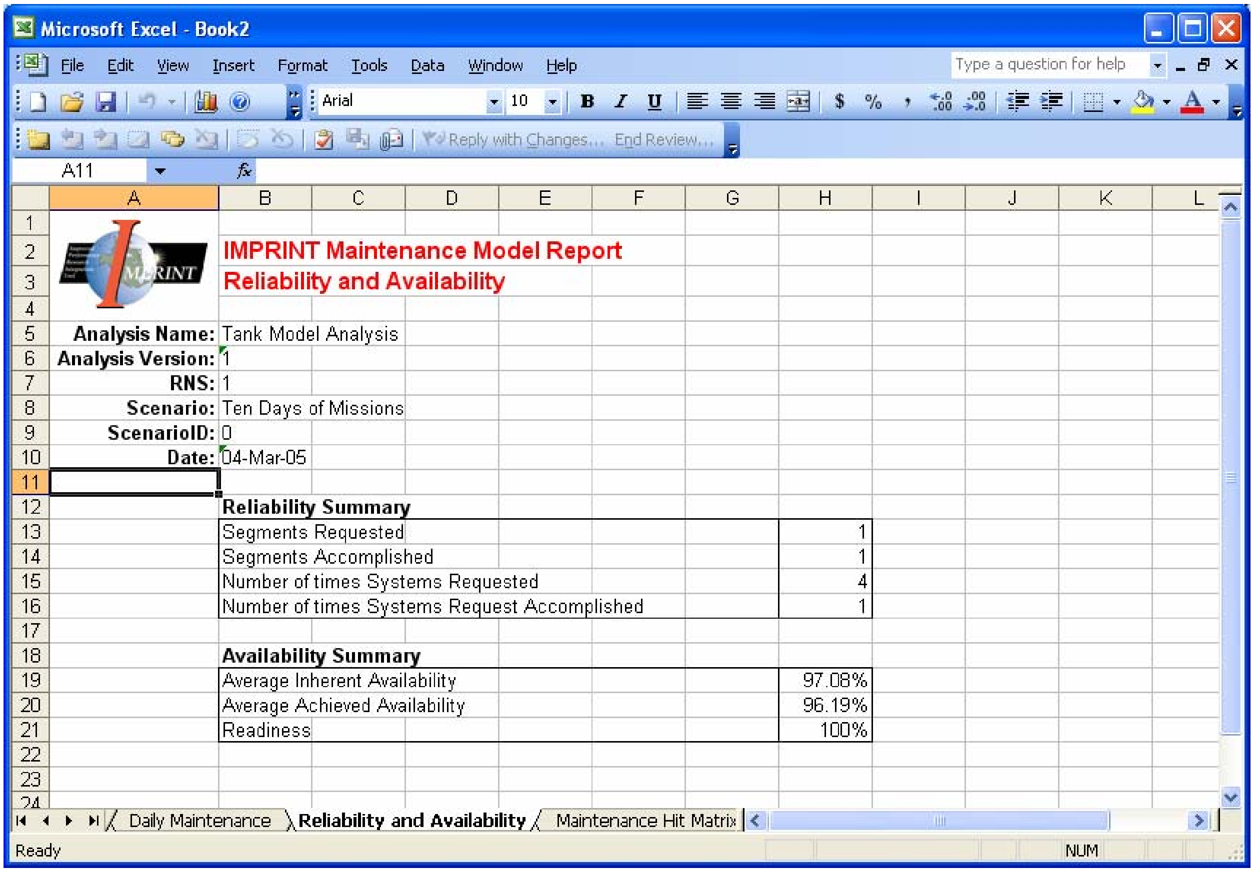
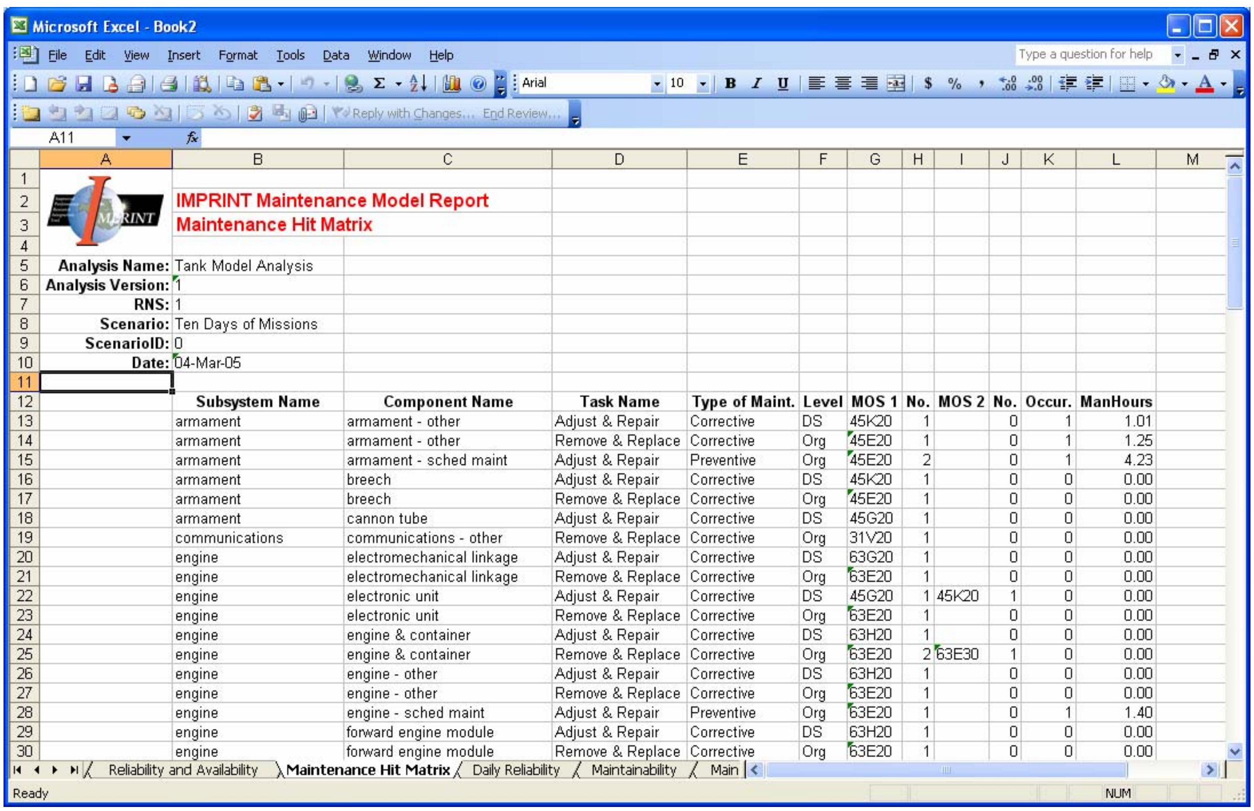


Figure 3-74. Reliability and Availability Report

Maintenance Hit Matrix Report

This report is an exhaustive listing of the maintenance tasks that occurred during your simulation. The columns of the report are:

- Subsystem Name
- Component Name
- Task Name
- Maintenance Task Type (Preventive or Corrective)
- Organizational level type at which the maintenance action will be performed (e.g., ORG, DS, GS)
- First MOS that was assigned to perform the maintenance action
- Number of maintainers of the first MOS that must work together to perform the task
- Second MOS that was assigned to perform the maintenance action
- Number of maintainers of the second MOS that must work together to perform the task
- The number of times the task was triggered during the simulation, or "occurrences"
- Total maintenance manhours simulated on the maintenance action


IMPRINT Maintenance Model Report
Maintenance Hit Matrix

Analysis Name: Tank Model Analysis
Analysis Version: 1
RNS: 1
Scenario: Ten Days of Missions
ScenarioID: 0
Date: 04-Mar-05

Subsystem Name	Component Name	Task Name	Type of Maint.	Level	MOS 1	No.	MOS 2	No.	Occur.	ManHours
armament	armament - other	Adjust & Repair	Corrective	DS	45K20	1		0	1	1.01
armament	armament - other	Remove & Replace	Corrective	Org	45E20	1		0	1	1.25
armament	armament - sched maint	Adjust & Repair	Preventive	Org	45E20	2		0	1	4.23
armament	breech	Adjust & Repair	Corrective	DS	45K20	1		0	0	0.00
armament	breech	Remove & Replace	Corrective	Org	45E20	1		0	0	0.00
armament	cannon tube	Adjust & Repair	Corrective	DS	45G20	1		0	0	0.00
communications	communications - other	Remove & Replace	Corrective	Org	31V20	1		0	0	0.00
engine	electromechanical linkage	Adjust & Repair	Corrective	DS	63G20	1		0	0	0.00
engine	electromechanical linkage	Remove & Replace	Corrective	Org	63E20	1		0	0	0.00
engine	electronic unit	Adjust & Repair	Corrective	DS	45G20	1	45K20	1	0	0.00
engine	electronic unit	Remove & Replace	Corrective	Org	63E20	1		0	0	0.00
engine	engine & container	Adjust & Repair	Corrective	DS	63H20	1		0	0	0.00
engine	engine & container	Remove & Replace	Corrective	Org	63E20	2	63E30	1	0	0.00
engine	engine - other	Adjust & Repair	Corrective	DS	63H20	1		0	0	0.00
engine	engine - other	Remove & Replace	Corrective	Org	63E20	1		0	0	0.00
engine	engine - sched maint	Adjust & Repair	Preventive	Org	63E20	1		0	1	1.40
engine	forward engine module	Adjust & Repair	Corrective	DS	63H20	1		0	0	0.00
engine	forward engine module	Remove & Replace	Corrective	Org	63E20	1		0	0	0.00

Figure 3-75. Maintenance Hit Matrix Report

This maintenance hit matrix also includes maintenance tasks that never occurred. You will identify those actions by noting the zeros in the "Occurrences", or number of occurrences, column. If many of your tasks have not occurred, it indicates that your simulation did not run long enough for the system to require these maintenance tasks (i.e., the mean operational units between failure (MOUBF) for the tasks are longer than the simulation time period). This probably indicates that you should lengthen the simulation run, and re-execute the model.

Since maintenance tasks are triggered by comparing their MOUBF to a standard exponential curve of accrued usage on each component in the system, there is some randomness associated with simulating when the maintenance task will occur. For this reason, we recommend that you execute the IMPRINT scenario with a variety of random number seeds to ensure that you have generated a representative set of results.

Contact Team Hit Matrix Report

The contact team hit matrix report has results displayed only if the maintenance task has been performed at the contact team level.

This report is an exhaustive listing of the maintenance tasks that occurred during your simulation. The report scrolls up and down. The columns of the report are:

- Subsystem Name
- Component Name
- Task Name
- Maintenance Task Type (Preventive or Corrective)
- MOS that was needed to perform the maintenance action (note that CTXXX is used to denote a member of the crew)
- Number of Contact Team maintainers needed to perform the task
- The number of times the task was triggered during the simulation
- Total maintenance manhours simulated on the maintenance action

If the contact team does not perform any maintenance action for the run then this report does not have any results.

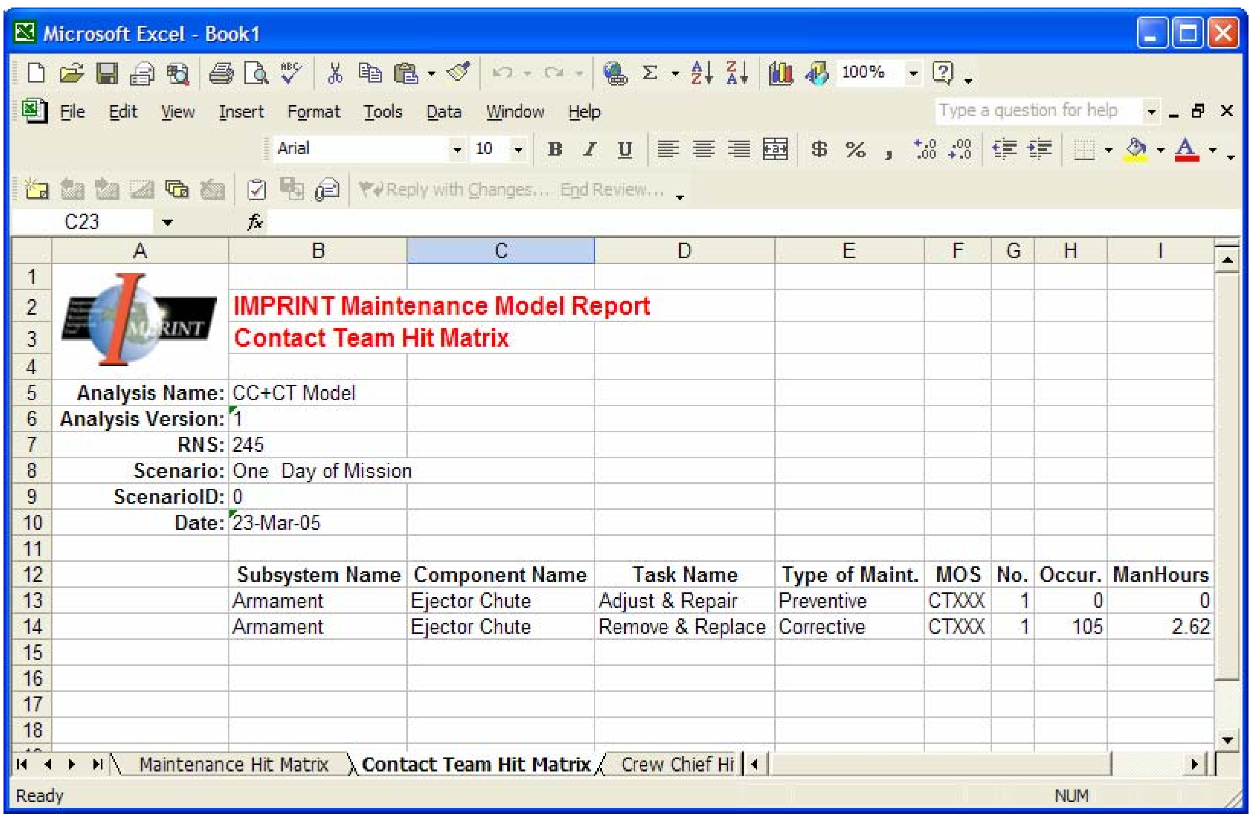


Figure 3-76. Contact Team Hit Matrix Report

Crew Chief Hit Matrix Report

The crew chief hit matrix report has results displayed only if the maintenance task has been performed at the crew level.

This report is an exhaustive listing of the maintenance tasks that occurred during your simulation. The report scrolls up and down. The columns of the report are:

- Subsystem Name
- Component Name
- Task Name
- Maintenance Task Type (Preventive or Corrective)
- MOS that was assigned to perform the maintenance action (note that CCXXX is used to denote a member of the crew)
- Number of maintainers needed to perform the task
- The number of times the task was triggered during the simulation
- Total maintenance manhours simulated on the maintenance action

If the crew does not perform any maintenance action for the run then this report does not have any results.

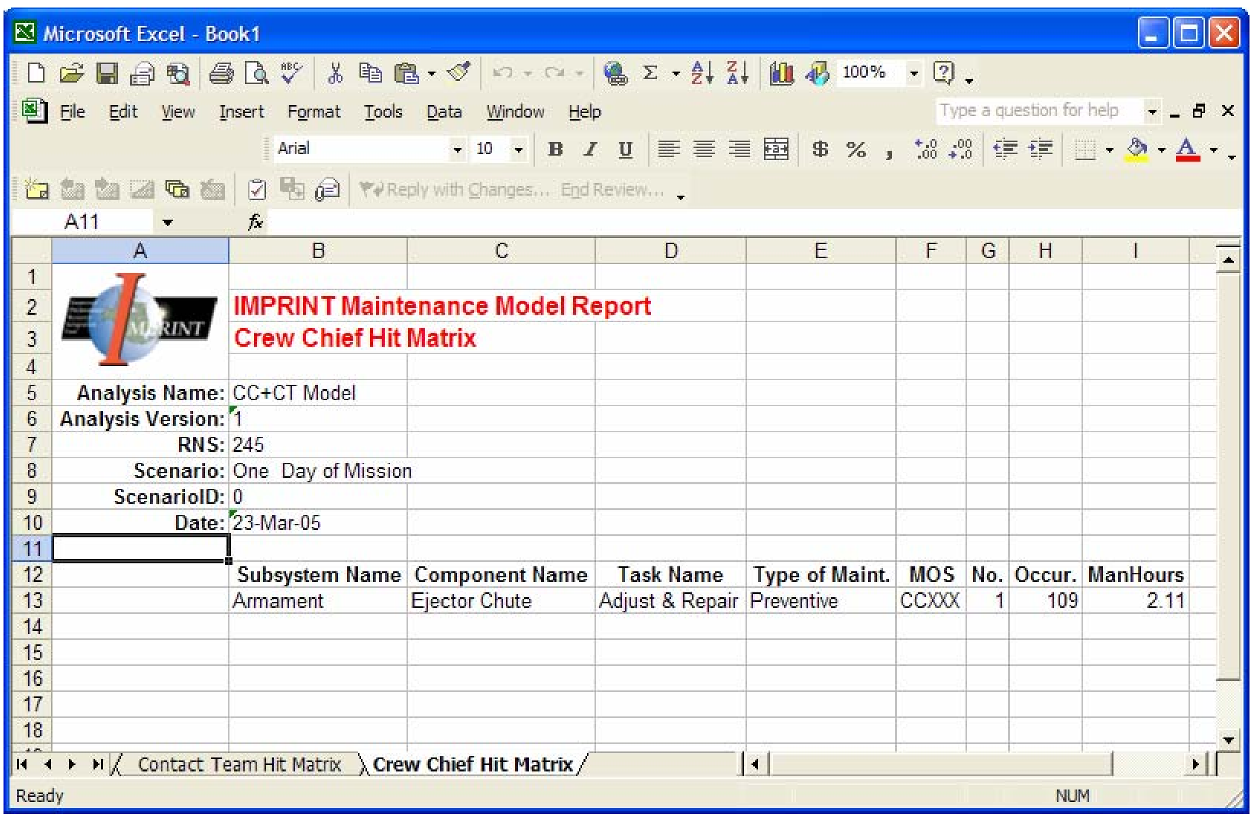
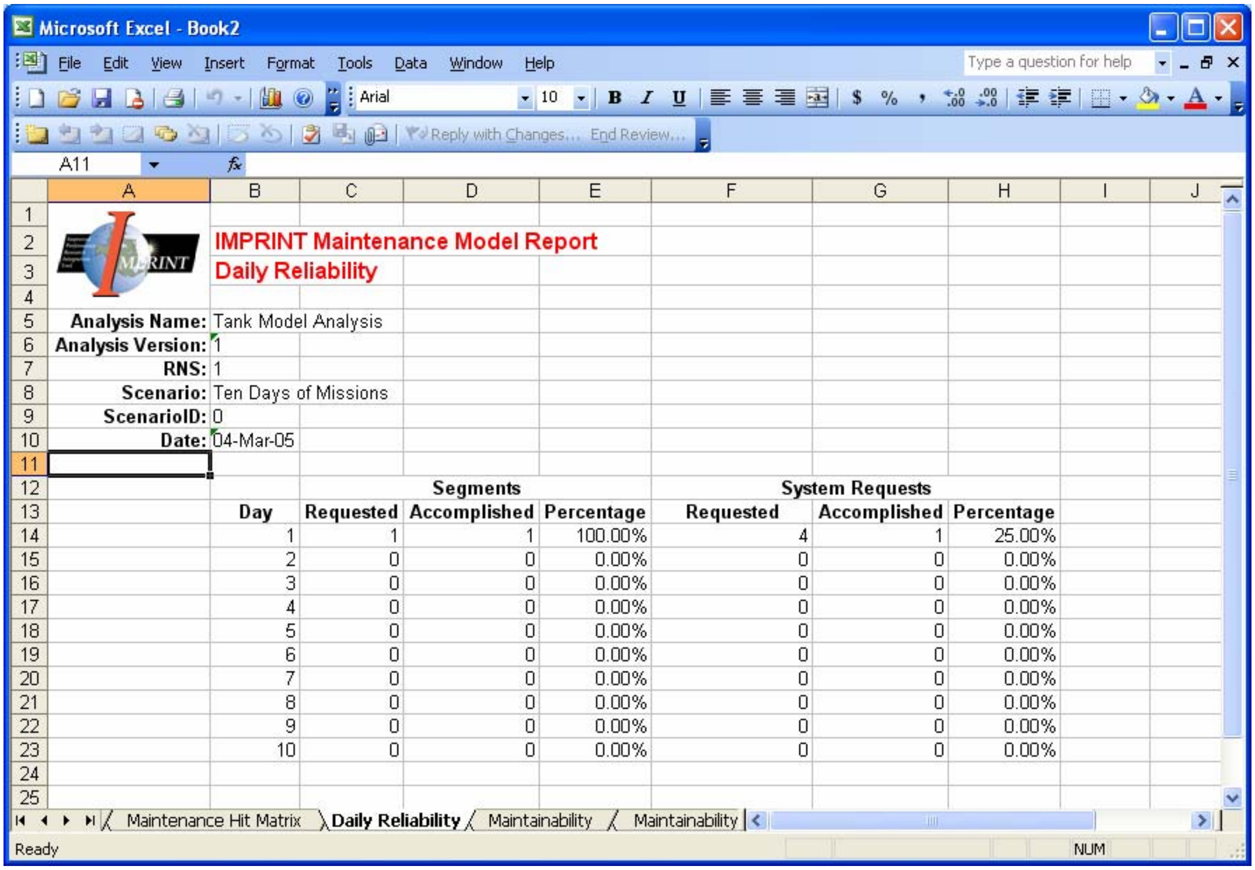


Figure 3-77. Crew Chief Hit Matrix Report

Daily Reliability Report

For each day of the scenario, the daily reliability report provides a summary of the number of segments requested, the number of segments accomplished (generated by the simulation), and the percentage of the requested segments that were accomplished.

Similarly, the daily reliability report also provides a summary of the number of systems requested, the number of systems accomplished (generated by the simulation), and the percentage of the requested systems that were accomplished.



IMPRINT Maintenance Model Report
Daily Reliability

Analysis Name: Tank Model Analysis
Analysis Version: 1
RNS: 1
Scenario: Ten Days of Missions
ScenarioID: 0
Date: 04-Mar-05

	Segments			System Requests		
Day	Requested	Accomplished	Percentage	Requested	Accomplished	Percentage
1	1	1	100.00%	4	1	25.00%
2	0	0	0.00%	0	0	0.00%
3	0	0	0.00%	0	0	0.00%
4	0	0	0.00%	0	0	0.00%
5	0	0	0.00%	0	0	0.00%
6	0	0	0.00%	0	0	0.00%
7	0	0	0.00%	0	0	0.00%
8	0	0	0.00%	0	0	0.00%
9	0	0	0.00%	0	0	0.00%
10	0	0	0.00%	0	0	0.00%

Figure 3-78. Daily Reliability Report

Supply and Support Report

This report, shown in the figure below, contains the fuel and ammunition requirements for supporting a mission. These support requirements are based on the daily fuel and ammunition requirements for a particular scenario entered under Define Equipment and the capacity and manpower available per transporter entered under Define Supply. The columns of the report are:

- Subsystem name
- Transporter name
- Total number of trips needed
- First MOS that was assigned to transport the fuel
- Number of the transporters of the first MOS that must work together to perform the task
- Second MOS that was assigned to transport the fuel
- Number of the transporters of the second MOS that must work together to perform the task

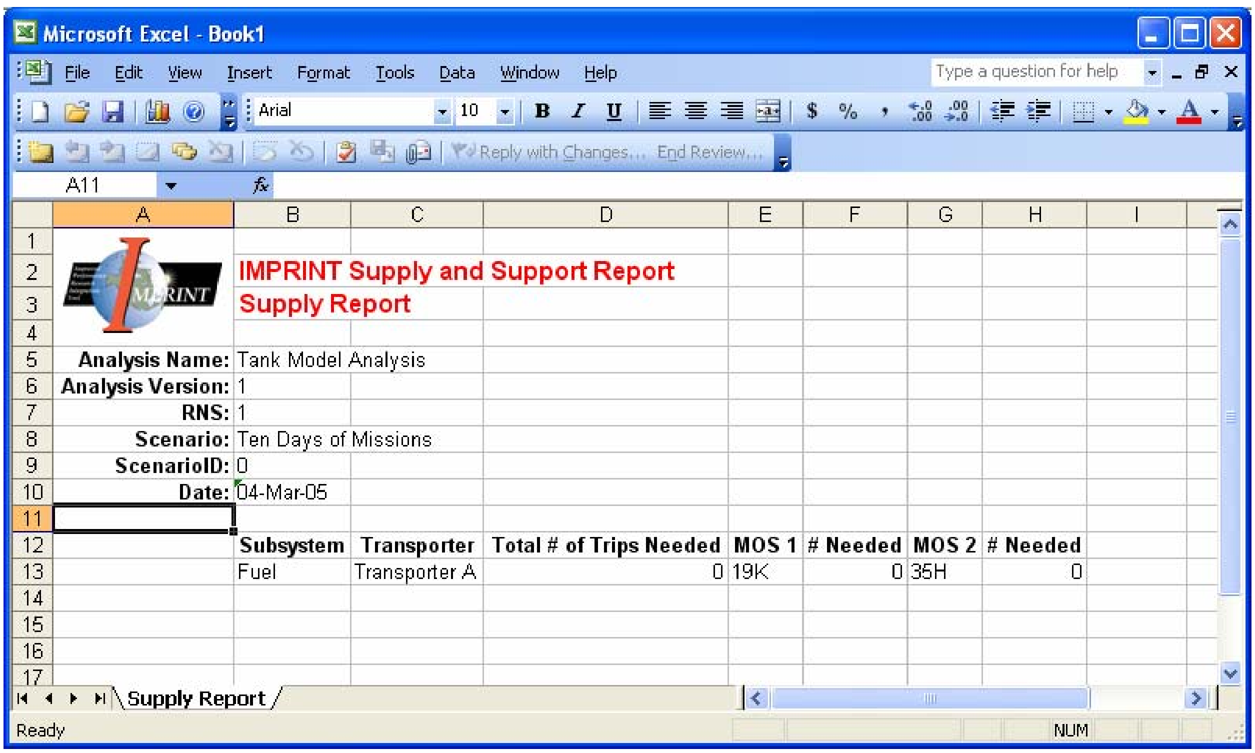
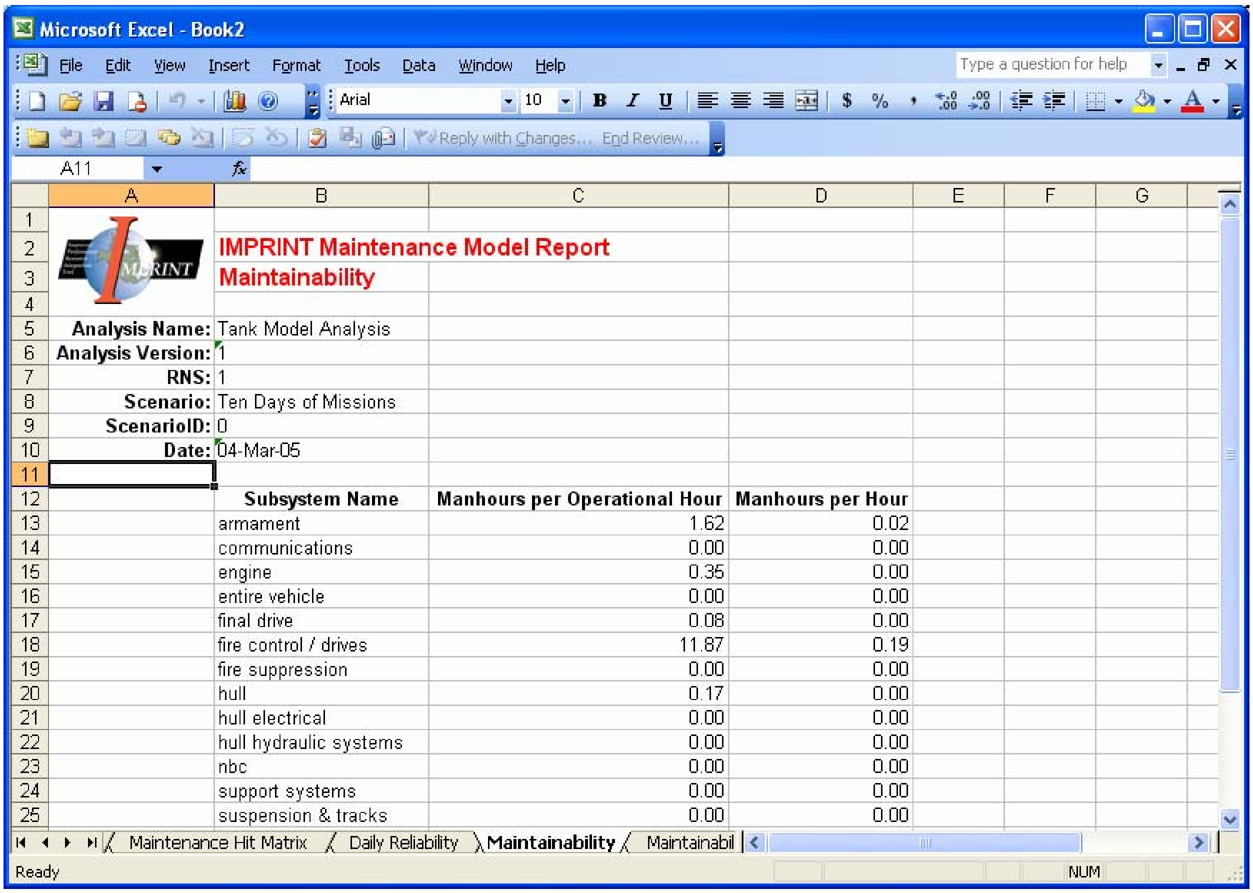


Figure 3-79. Supply and Support Report

Maintainability Report

This report includes simulated maintenance man-hours per operational hour. This measure is calculated by dividing the total man-hours of maintenance performed on each subsystem by the total number of operational hours of the scenario.

This report also includes simulated man-hours per hour. This measure is calculated by dividing the total man-hours of maintenance performed on each subsystem by the total length of the scenario (in hours).


Microsoft Excel - Book2

IMPRINT Maintenance Model Report
Maintainability

Analysis Name:	Tank Model Analysis
Analysis Version:	1
RNS:	1
Scenario:	Ten Days of Missions
ScenarioID:	0
Date:	04-Mar-05

Subsystem Name	Manhours per Operational Hour	Manhours per Hour
armament	1.62	0.02
communications	0.00	0.00
engine	0.35	0.00
entire vehicle	0.00	0.00
final drive	0.08	0.00
fire control / drives	11.87	0.19
fire suppression	0.00	0.00
hull	0.17	0.00
hull electrical	0.00	0.00
hull hydraulic systems	0.00	0.00
nbc	0.00	0.00
support systems	0.00	0.00
suspension & tracks	0.00	0.00

Maintenance Hit Matrix / Daily Reliability / Maintainability / Maintainabil

Figure 3-80. Maintainability Report

Maintainability Graph

This graph provides a histogram of the manhours needed to perform maintenance on each subsystem of your system. The histogram includes two types of data: 1) the number of maintenance manhours per operational hour (typically referred to as the maintenance ratio), and 2) the number of maintenance manhours per hour of the scenario.

The histogram provides a graphical presentation of the same data that are displayed in the Maintainability report.

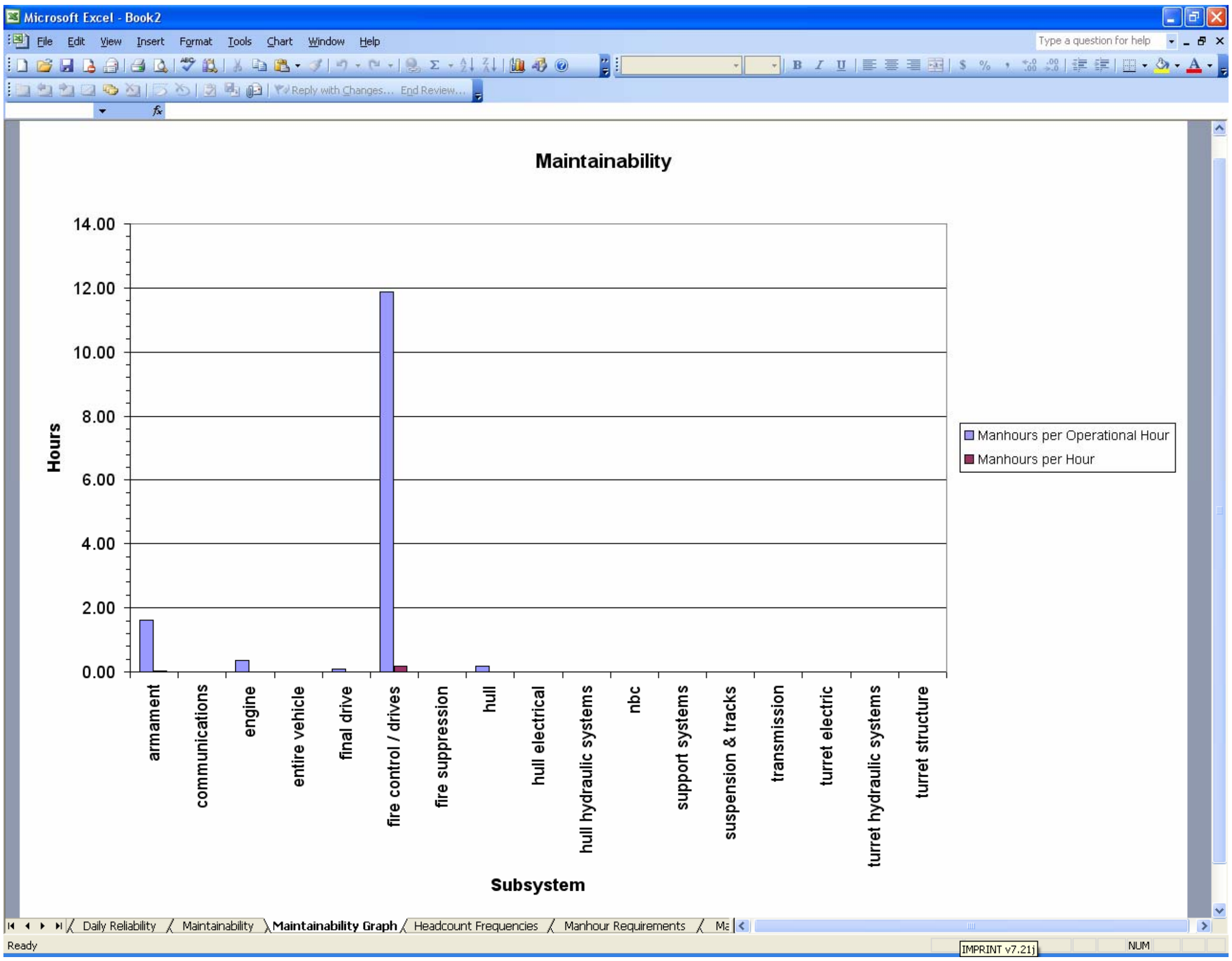
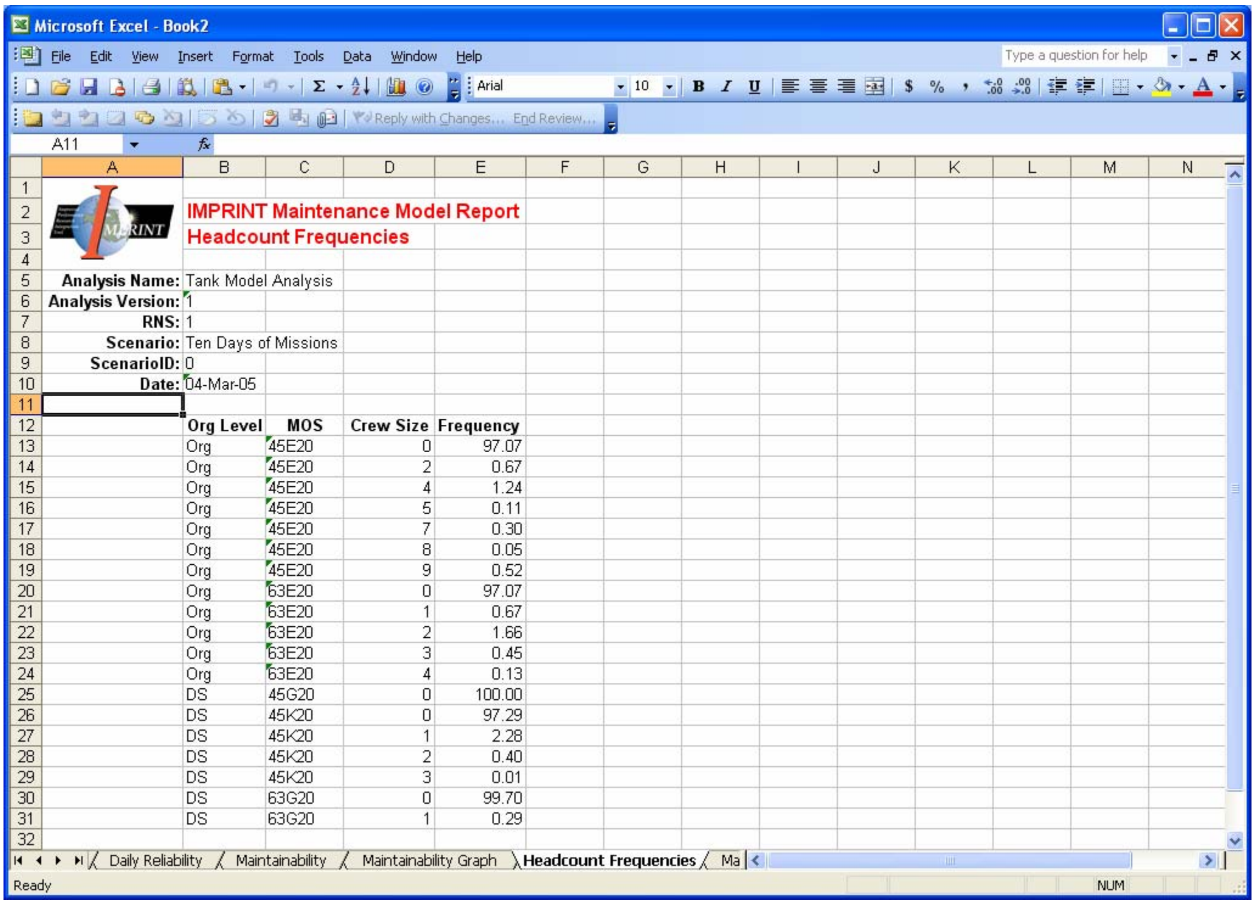


Figure 3-81. Maintainability Graph

Headcount Frequencies Report

This report provides a measure of MOS utilization, or more specifically, it illustrates the frequency with which different numbers of people in each MOS were used and over all organizational level types (e.g., ORG, DS, GS). This report is based on the entire length of the simulation, not just the times during the simulation that this MOS was busy or on duty.

The highest bin for which a > 0% utilization is shown will never exceed the shift manning levels you set for that MOS and that organizational level type. Additionally, if the highest bin shown has a relatively high frequency, as in the example of 20% of the time three people being used, then it is possible that you have constrained this MOS so tightly that it is reducing system availability.


IMPRINT Maintenance Model Report
Headcount Frequencies

Analysis Name: Tank Model Analysis
Analysis Version: 1
RNS: 1
Scenario: Ten Days of Missions
ScenarioID: 0
Date: 04-Mar-05

Org Level	MOS	Crew Size	Frequency
Org	45E20	0	97.07
Org	45E20	2	0.67
Org	45E20	4	1.24
Org	45E20	5	0.11
Org	45E20	7	0.30
Org	45E20	8	0.05
Org	45E20	9	0.52
Org	63E20	0	97.07
Org	63E20	1	0.67
Org	63E20	2	1.66
Org	63E20	3	0.45
Org	63E20	4	0.13
DS	45G20	0	100.00
DS	45K20	0	97.29
DS	45K20	1	2.28
DS	45K20	2	0.40
DS	45K20	3	0.01
DS	63G20	0	99.70
DS	63G20	1	0.29

Figure 3-82. Headcount Frequencies Report

As an example, consider the report shown in the figure above. Notice that in the MOS column, the results for the 35H20 at the ORG Level show a frequency of 100% for the crew size of 0. This means that the 35H20 maintainer was never utilized at the ORG level in this scenario. In contrast, view the subsequent rows of the report. Those data indicate the frequency for the 45E20. From these results, you see that 29.10% of the scenario time, the 45E20 was idle. In other words, if the scenario was 10 days long, then the 45E20 was busy during all but 29.10% (69.84 hours) of that time.

During 11.35% of the scenario, one 45E20 soldier was busy performing maintenance. During 12.34% of the time, two soldiers were busy at the same time, and 7.73% of the time, three soldiers were busy, and so on. You will notice that the frequency stays above 0 all the way through the crew size of 19. This indicates that the 45E20 was heavily utilized, and that the scenario probably was executed with an unconstrained manpower pool for the 45E20 (we do know for certain from these results that the pool was >19).

We recommend that you perform the first IMPRINT maintenance model run with the shift manning levels unconstrained. This will result in a simulation that optimizes system availability from the perspective of manpower. Put another way, the simulation will assume that the manpower required to perform any maintenance action will be available. After running the IMPRINT maintenance model in the unconstrained mode, you should examine this Headcount Frequency report for guidance on how to best constrain your shift manning pools (i.e., to minimize the effect on system availability). We recommend that you focus on reducing manpower pools for MOS' that have low utilizations.

Man-hour Requirements Report

This report has three columns. They are organizational level, MOS, and Direct Maintenance Man-hours. This report is useful for identifying the MOS' that are performing the most maintenance.

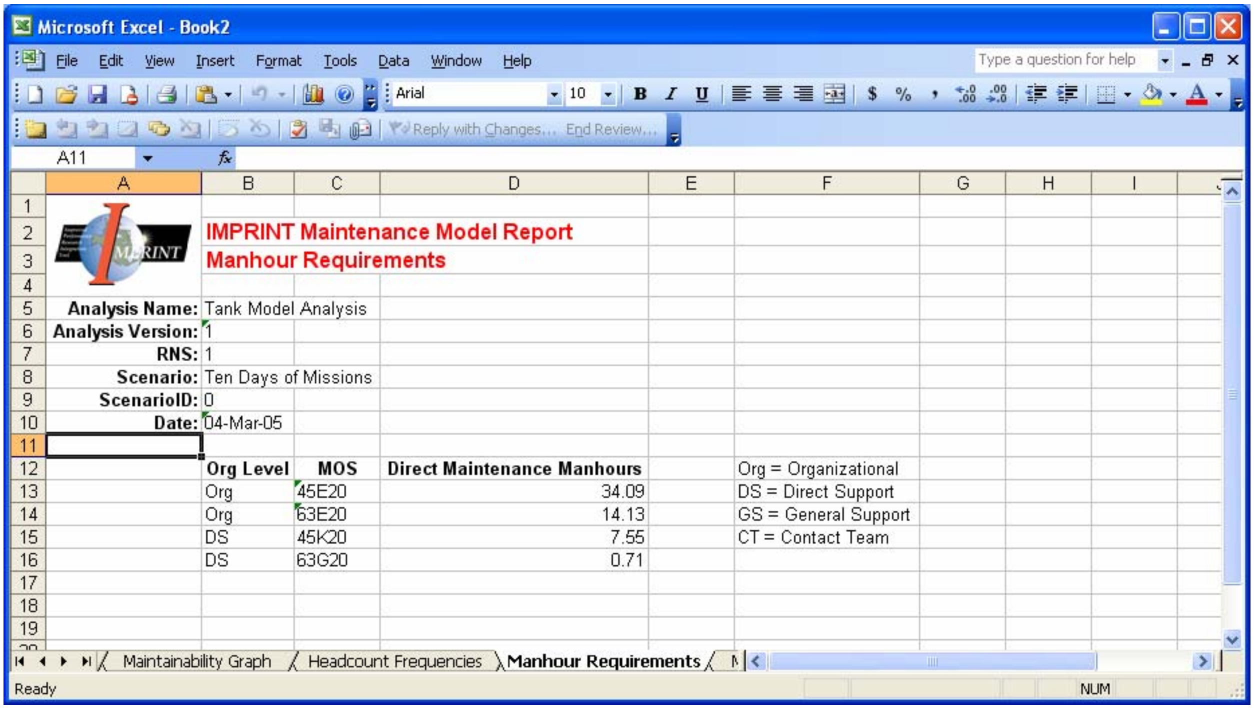


Figure 3-83. Manhour Requirements Report

Man-hour Requirements Graph

The Manhour Requirement Graph is a histogram that presents the same data as are in the Manhour Requirements Report. Each MOS at each organization level (GS, ORG and DS) is shown as an individual bar in the histogram. The height of the bar indicates the number of manhours expended by that MOS at that organizational level throughout the scenario.

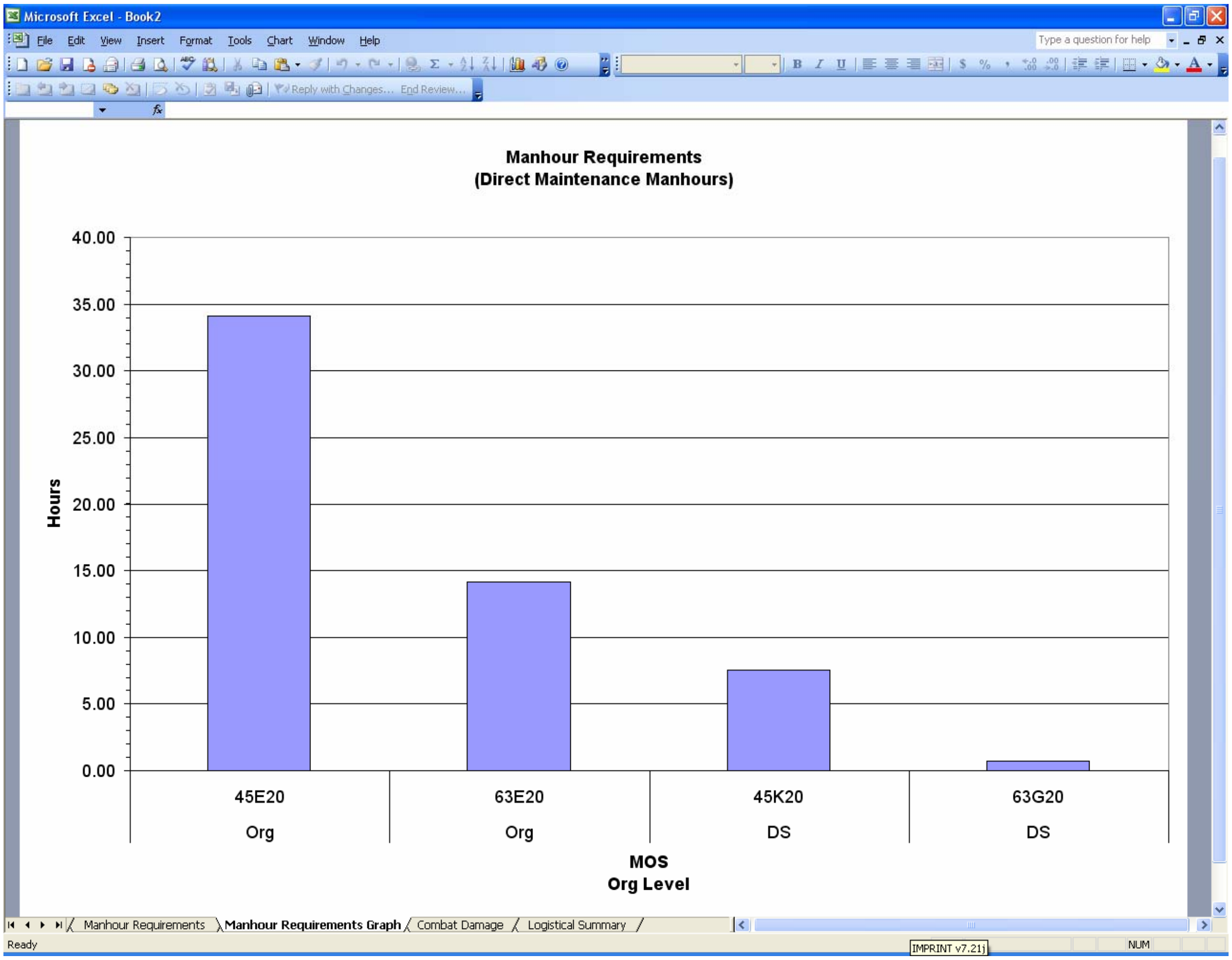


Figure 3-84. Manhour Requirements Graph

Combat Damage Report

This is a brief report that lists the number of combat hits that were simulated for all your systems throughout the entire length of the simulation run. This report also lists the number of simulated attritions, or kills. Finally, this report also shows the required repair time in total number of hours.

It should be noted that these metrics are stochastically driven because of the combat parameters entered earlier in IMPRINT. These combat parameters are mission-specific and include the probability of combat hit per hour, the probability of attrition or repair, and the time it takes to either replace a destroyed system or repair a damaged system.

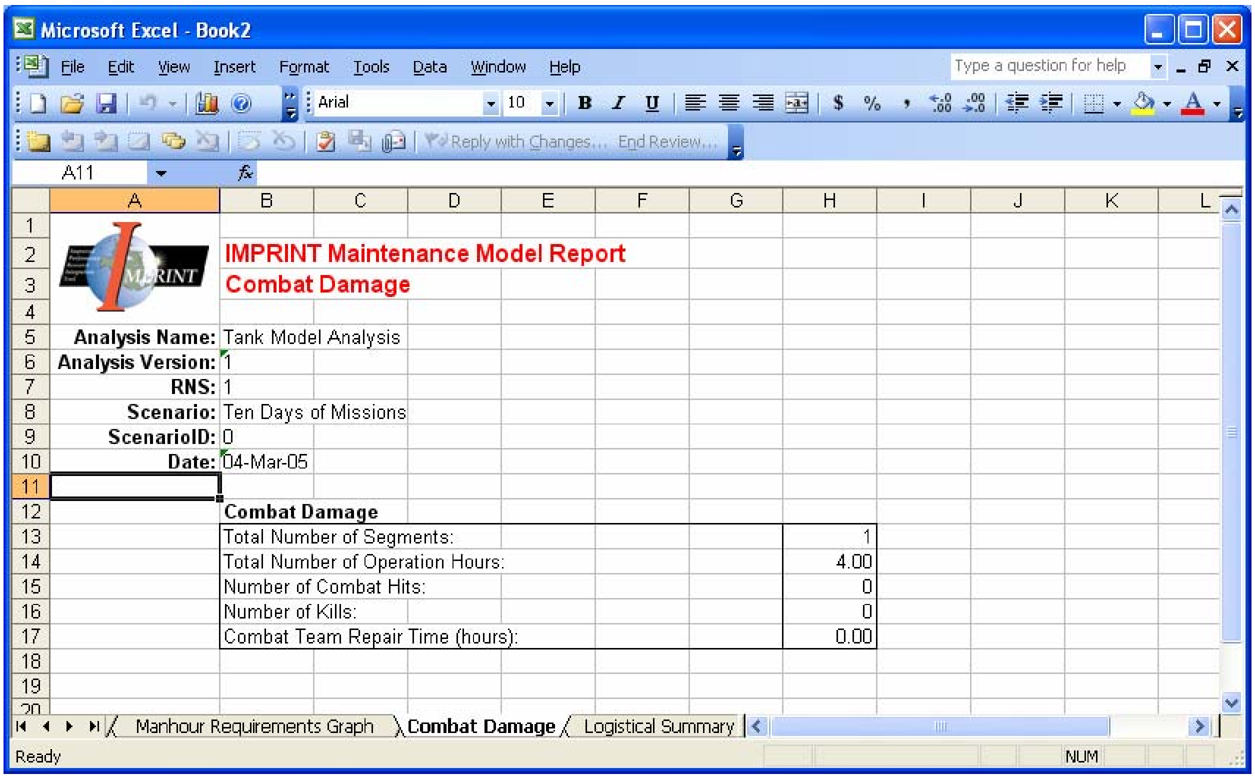


Figure 3-85. Combat Damage Report

Logistical Wait Summary

The Logistical Wait Summary Maintenance Report includes two measures. These measures are the amount of time systems spent waiting for spare parts and the amount of time systems spent waiting for maintainers. Each of these measures are reported by organizational level.

If there is an excessive amount of time in which systems are spent waiting for spare parts, you will want to either increase the probability that spares are available or decrease the amount of time required to procure a spare under the "spares" button in Define Equipment.

If there is an excessive amount of time in which systems are spent waiting for maintainers, you will either want to increase the number of people in your manpower pools, or you should increase your shift lengths, or you could decrease the operational profile for your systems. Each of these options are available under the Define Equipment portion of IMPRINT.

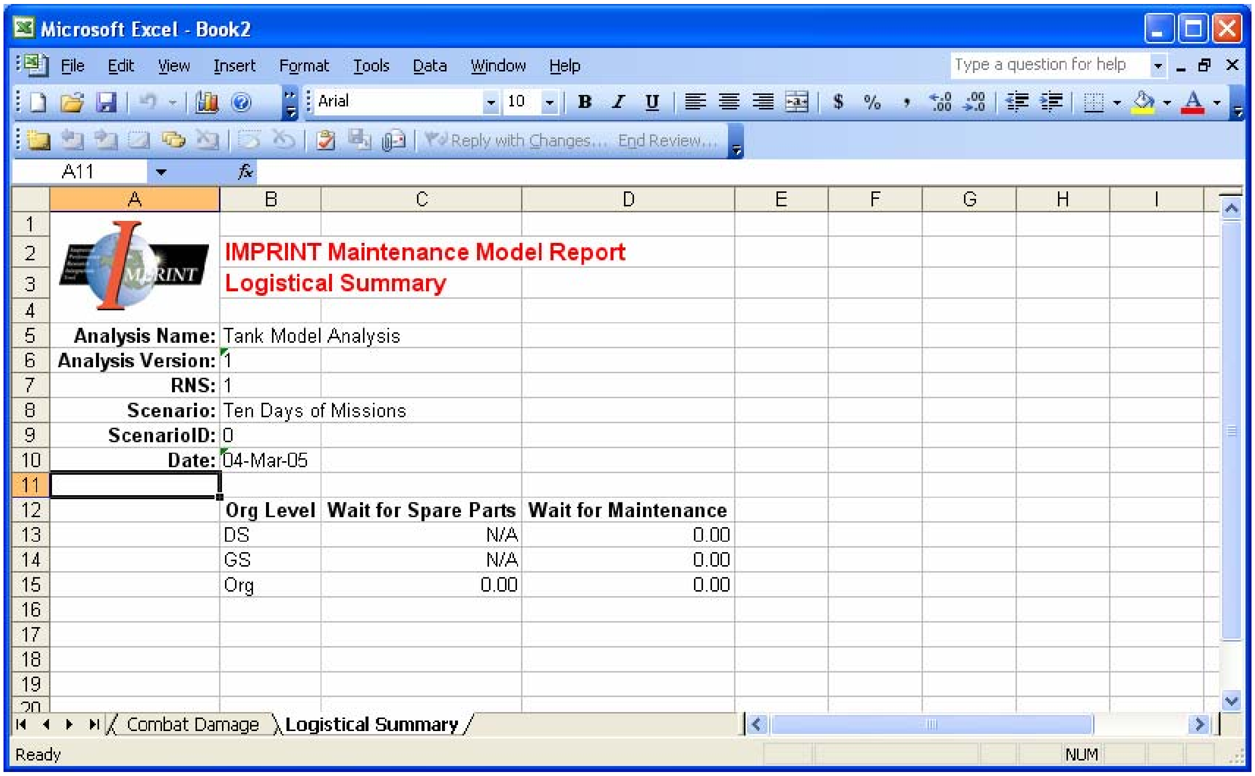


Figure 3-86. Logistical Summary Report

Personnel Attributes

The Personnel Attributes section of the Reports menu comprises all report options related to either Personnel Characteristics or Projected MOS Inventory. On selecting this option, you will see a new dialog which prompts you to check the report options for either category.

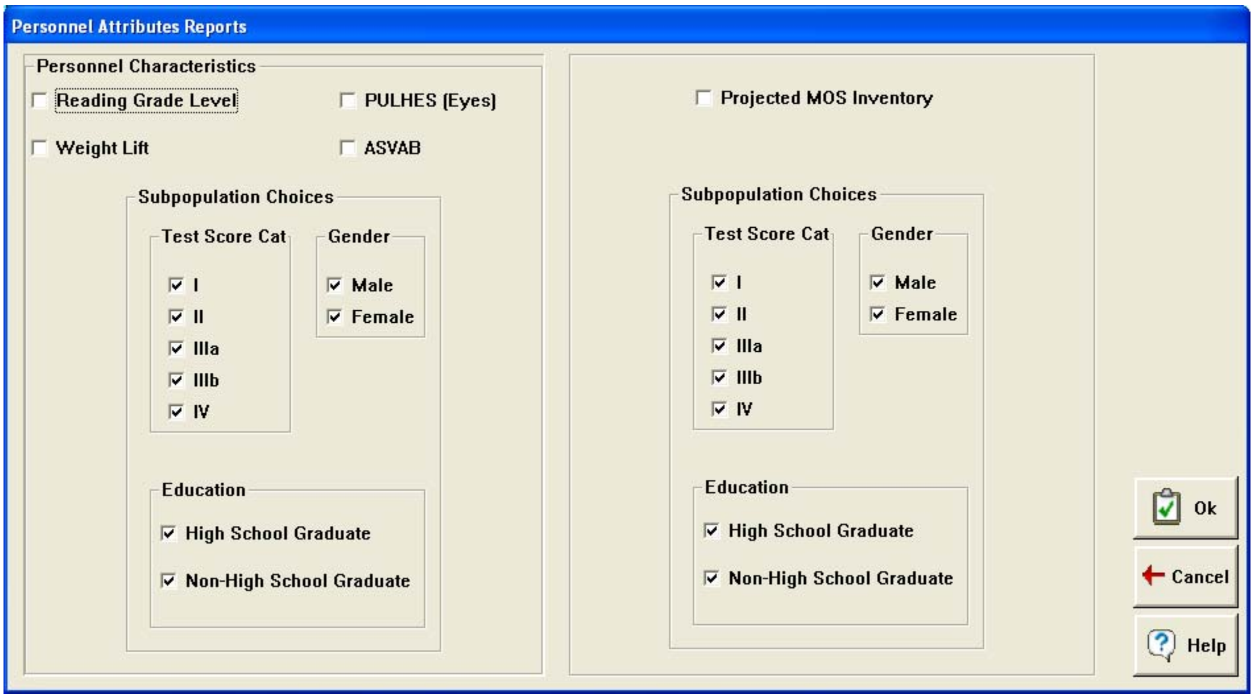


Figure 3-87. Personnel Attributes Report Dialog

Select the type of report you wish to view and filters you wish to use by checking the corresponding boxes next to each item. Next, click the OK button.

Personnel Characteristics Reports

In the Personnel Characteristics window (left section of the window shown above), check the boxes for the reports you wish to view. Available options are Reading Grade Level, Weight Lift, PUSLES (Eyes) and ASVAB. Next click the OK button - a new Microsoft Excel workbook that contains a separate worksheet for each report is generated as shown in the figure below:

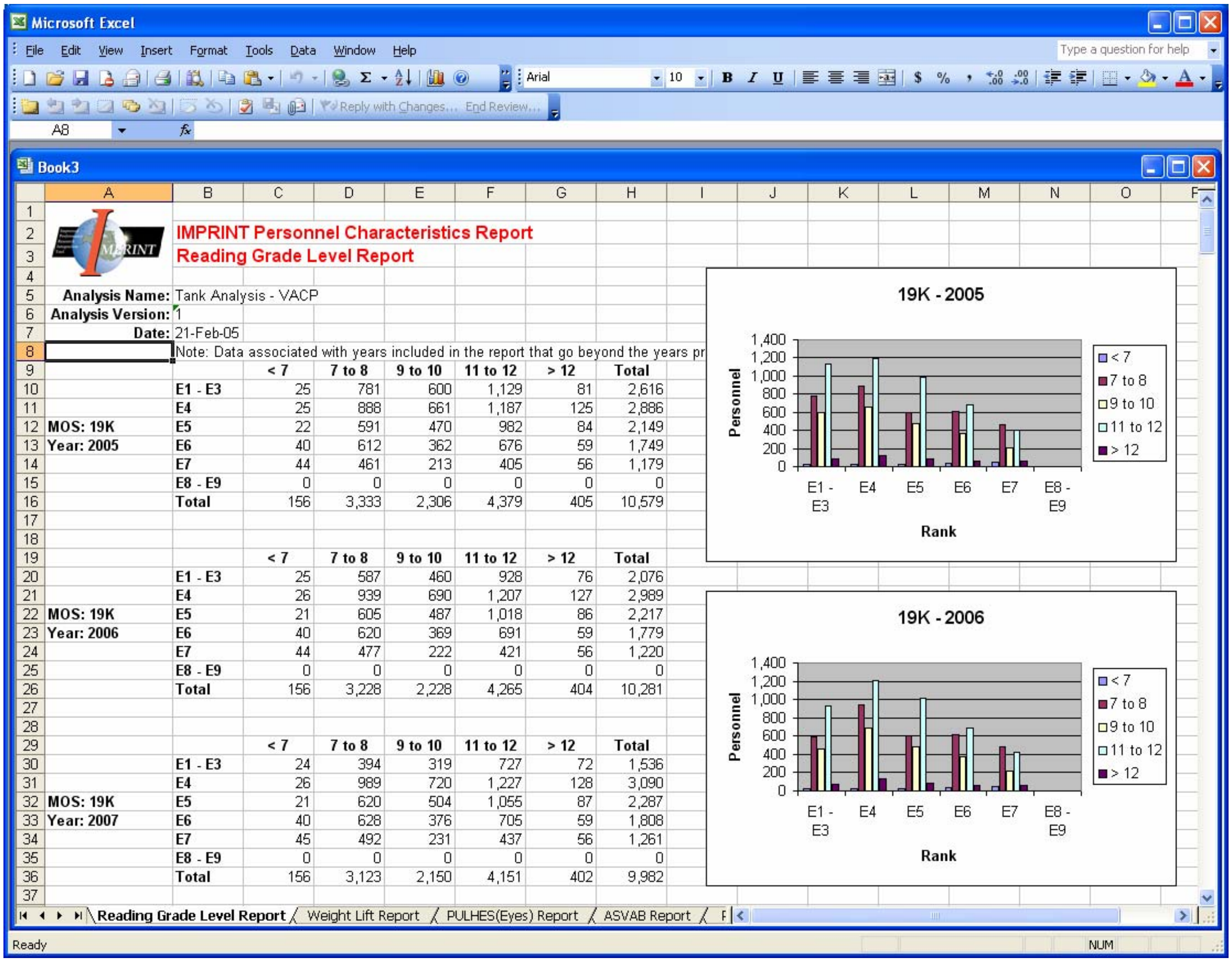


Figure 3-88. Projection Report Criteria

Reading Grade Level Report

This report lists the number of people in each Reading Grade Level Category for each enlistment grade (E1 through E9) and for a specific MOS and year. Next to the data table, you will see a histogram that presents the data graphically.

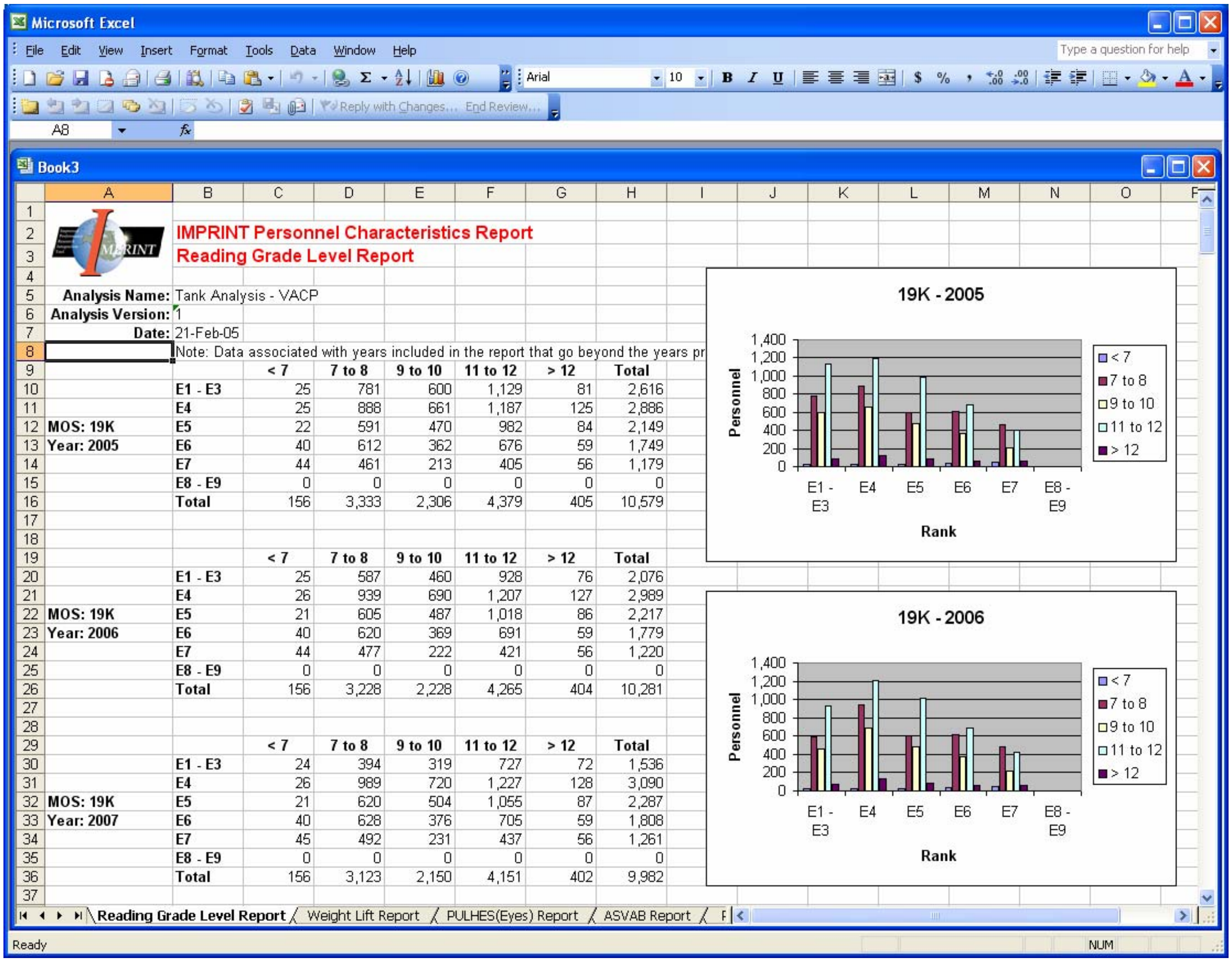
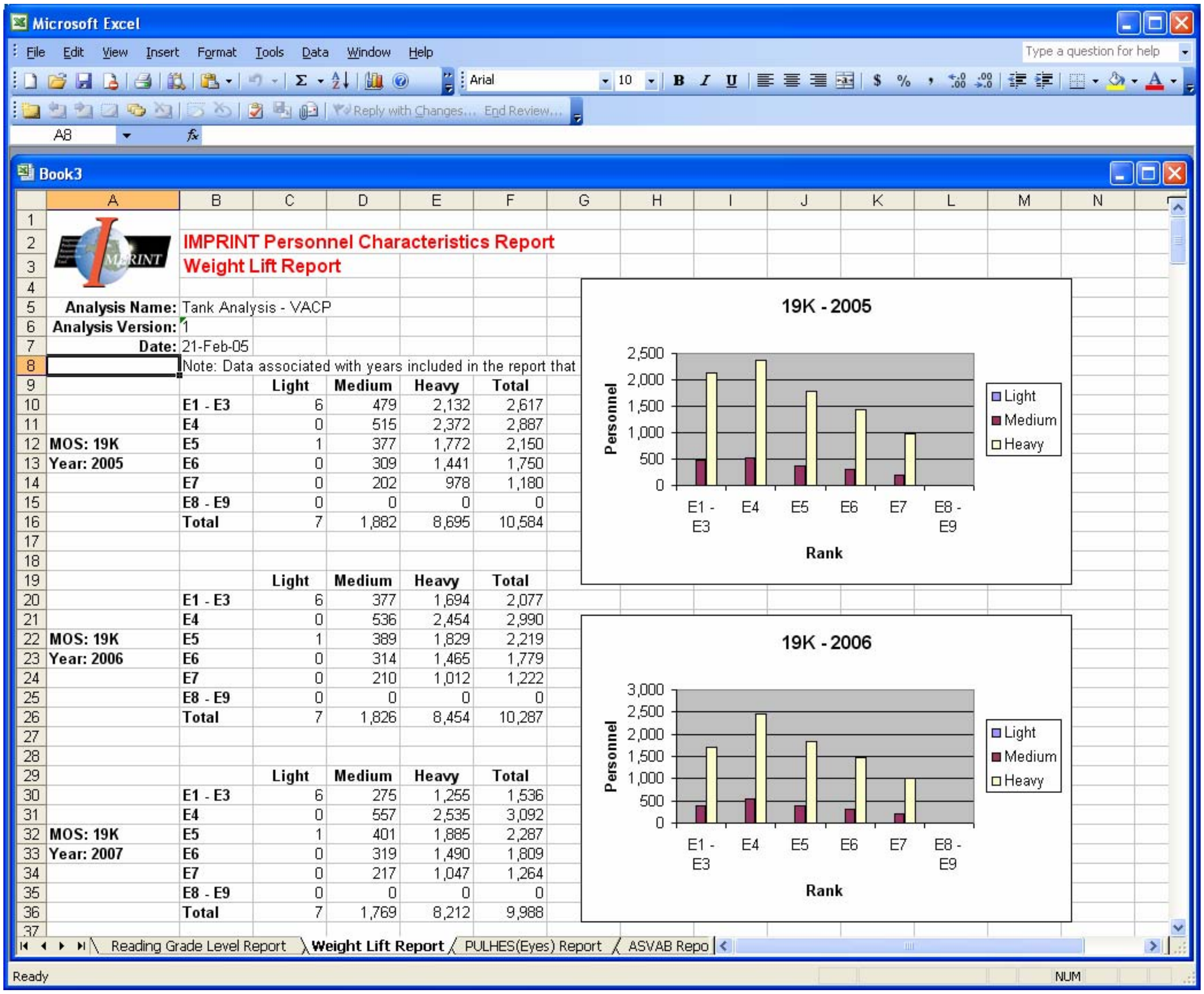


Figure 3-89. Reading Grade Level Report

Weight Lift Report

If you click on this button, a report displays numbers of people in each Weight Lift Category for each enlistment grade (E1 through E9) and for a specific MOS and year. Next to the data table, you will see a histogram that presents the data graphically.



		Light	Medium	Heavy	Total
	E1 - E3	6	479	2,132	2,617
	E4	0	515	2,372	2,887
MOS: 19K	E5	1	377	1,772	2,150
Year: 2005	E6	0	309	1,441	1,750
	E7	0	202	978	1,180
	E8 - E9	0	0	0	0
	Total	7	1,882	8,695	10,584

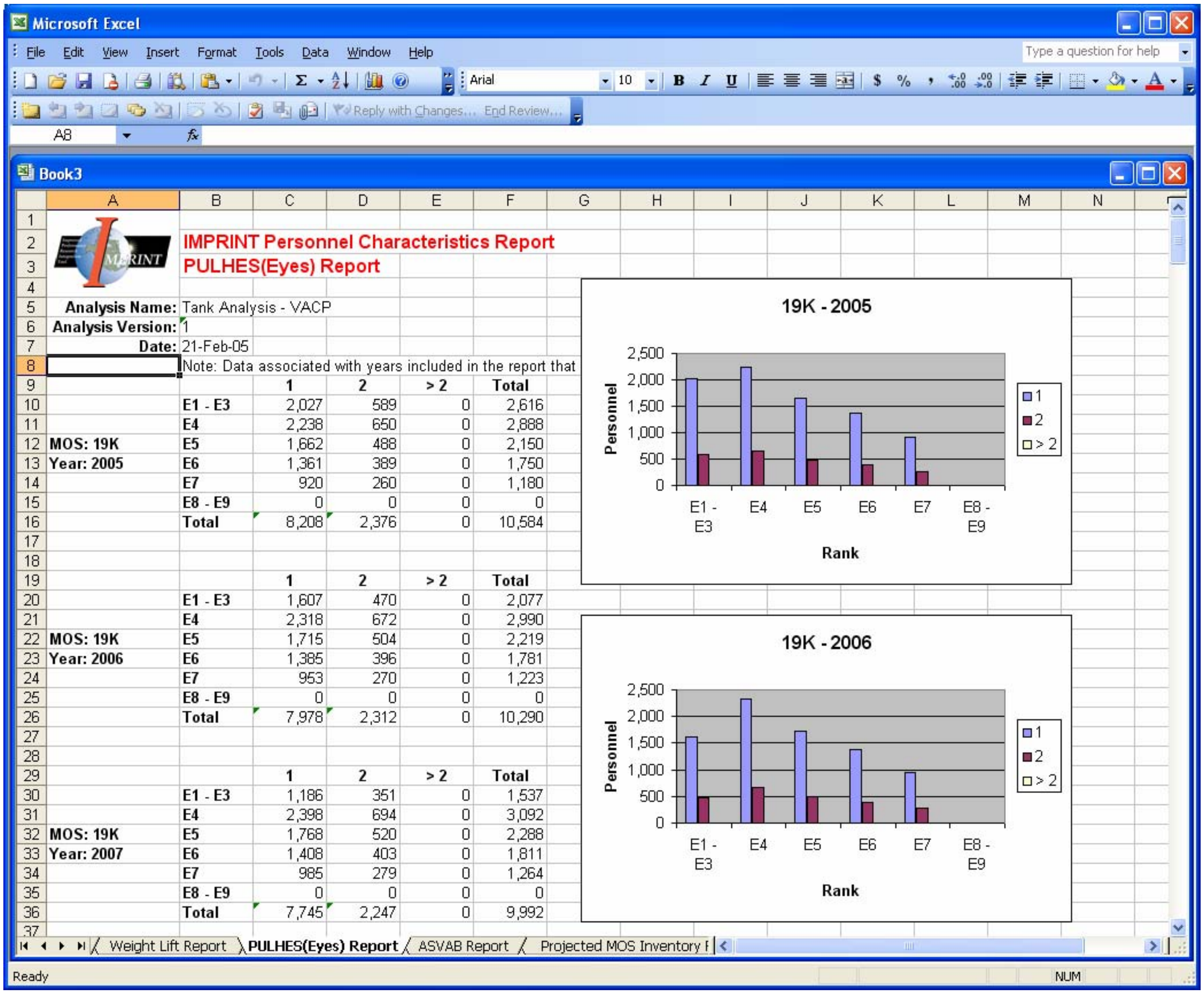
		Light	Medium	Heavy	Total
	E1 - E3	6	377	1,694	2,077
	E4	0	536	2,454	2,990
MOS: 19K	E5	1	389	1,829	2,219
Year: 2006	E6	0	314	1,465	1,779
	E7	0	210	1,012	1,222
	E8 - E9	0	0	0	0
	Total	7	1,826	8,454	10,287

		Light	Medium	Heavy	Total
	E1 - E3	6	275	1,255	1,536
	E4	0	557	2,535	3,092
MOS: 19K	E5	1	401	1,885	2,287
Year: 2007	E6	0	319	1,490	1,809
	E7	0	217	1,047	1,264
	E8 - E9	0	0	0	0
	Total	7	1,769	8,212	9,988

Figure 3-90. Weight Lift Report

PULHES (Eyes) Report

If you click on this button, a report displays the numbers of people in PULHES Eyes Category for each enlistment grade (E1 through E9) and for a specific MOS and year. Next to the data table, you will see a histogram that presents the data graphically.

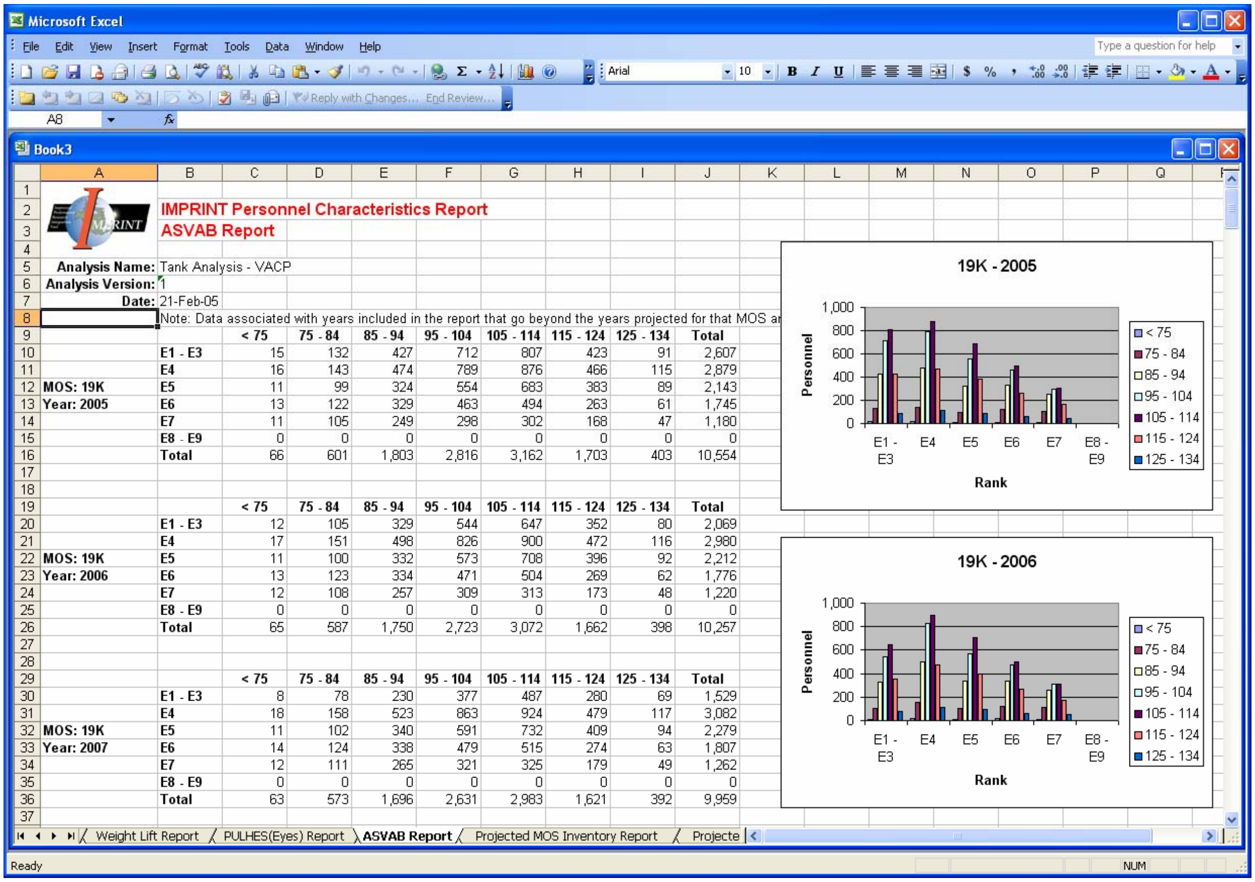


		1	2	> 2	Total
	E1 - E3	2,027	589	0	2,616
	E4	2,238	650	0	2,888
MOS: 19K	E5	1,662	488	0	2,150
Year: 2005	E6	1,361	389	0	1,750
	E7	920	260	0	1,180
	E8 - E9	0	0	0	0
	Total	8,208	2,376	0	10,584
		1	2	> 2	Total
	E1 - E3	1,607	470	0	2,077
	E4	2,318	672	0	2,990
MOS: 19K	E5	1,715	504	0	2,219
Year: 2006	E6	1,385	396	0	1,781
	E7	953	270	0	1,223
	E8 - E9	0	0	0	0
	Total	7,978	2,312	0	10,290
		1	2	> 2	Total
	E1 - E3	1,186	351	0	1,537
	E4	2,398	694	0	3,092
MOS: 19K	E5	1,768	520	0	2,288
Year: 2007	E6	1,408	403	0	1,811
	E7	985	279	0	1,264
	E8 - E9	0	0	0	0
	Total	7,745	2,247	0	9,992

Figure 3-91. PULHES (Eyes) Report

ASVAB Report

If you click on this button, a report displays the numbers of people at each ASVAB cutoff score for each enlistment grade (E1 through E9) and for a specific MOS and year. Next to the data table, you will see a histogram that presents the data graphically.



IMPRINT Personnel Characteristics Report
ASVAB Report

Analysis Name: Tank Analysis - VACP
Analysis Version: 1
Date: 21-Feb-05
Note: Data associated with years included in the report that go beyond the years projected for that MOS ar

		< 75	75 - 84	85 - 94	95 - 104	105 - 114	115 - 124	125 - 134	Total
	E1 - E3	15	132	427	712	807	423	91	2,607
	E4	16	143	474	789	876	466	115	2,879
MOS: 19K	E5	11	99	324	554	683	383	89	2,143
Year: 2005	E6	13	122	329	463	494	263	61	1,745
	E7	11	105	249	298	302	168	47	1,180
	E8 - E9	0	0	0	0	0	0	0	0
	Total	66	601	1,803	2,816	3,162	1,703	403	10,554
		< 75	75 - 84	85 - 94	95 - 104	105 - 114	115 - 124	125 - 134	Total
	E1 - E3	12	105	329	544	647	352	80	2,069
	E4	17	151	498	826	900	472	116	2,980
MOS: 19K	E5	11	100	332	573	708	396	92	2,212
Year: 2006	E6	13	123	334	471	504	269	62	1,776
	E7	12	108	257	309	313	173	48	1,220
	E8 - E9	0	0	0	0	0	0	0	0
	Total	65	587	1,750	2,723	3,072	1,662	398	10,257
		< 75	75 - 84	85 - 94	95 - 104	105 - 114	115 - 124	125 - 134	Total
	E1 - E3	8	78	230	377	487	280	69	1,529
	E4	18	158	523	863	924	479	117	3,082
MOS: 19K	E5	11	102	340	591	732	409	94	2,279
Year: 2007	E6	14	124	338	479	515	274	63	1,807
	E7	12	111	265	321	325	179	49	1,262
	E8 - E9	0	0	0	0	0	0	0	0
	Total	63	573	1,696	2,631	2,983	1,621	392	9,959

Figure 3-92. ASVAB Report

Projected MOS Inventory Report

The Projected MOS Inventory Report is generated from the results of the Projection Model. This report tells you the number of people in each MOS by grade.

To view the Projected MOS Inventory report, go to the Report menu and select the Personnel Attributes option. In the next screen to follow, skip to the Projected MOS Inventory section (right side of the window shown below.) Check the Projected MOS Inventory option at the top of this section and any optional filters below you wish to use in your report.

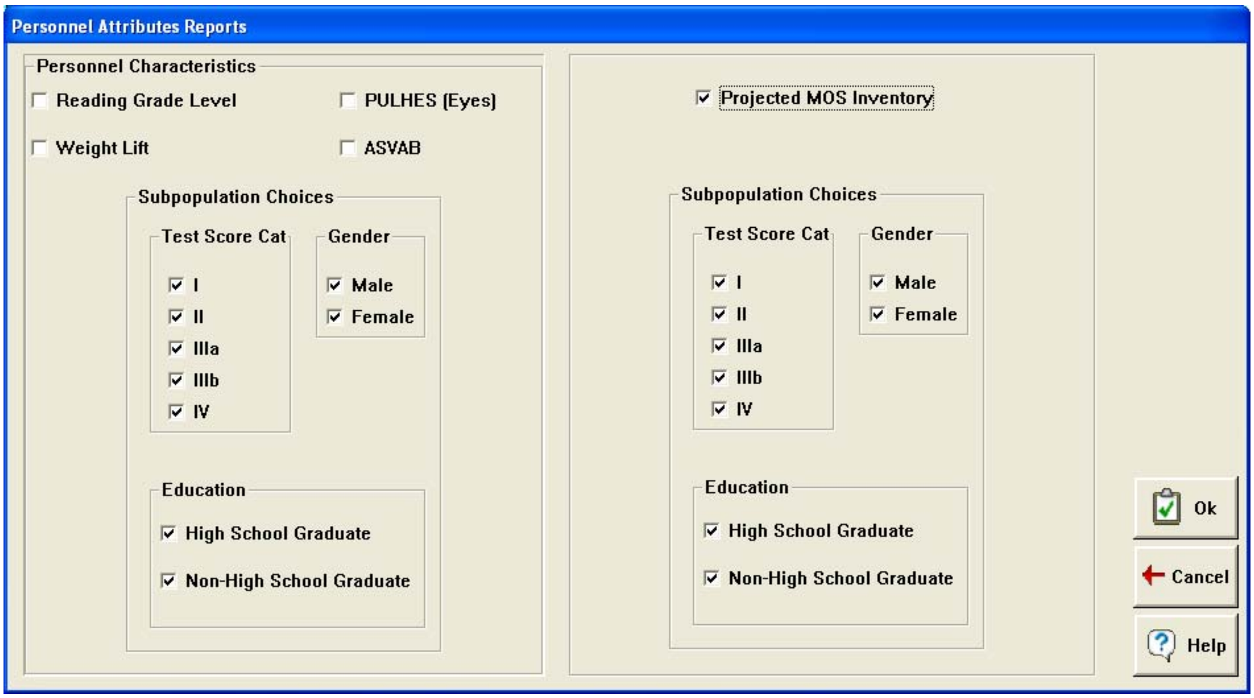
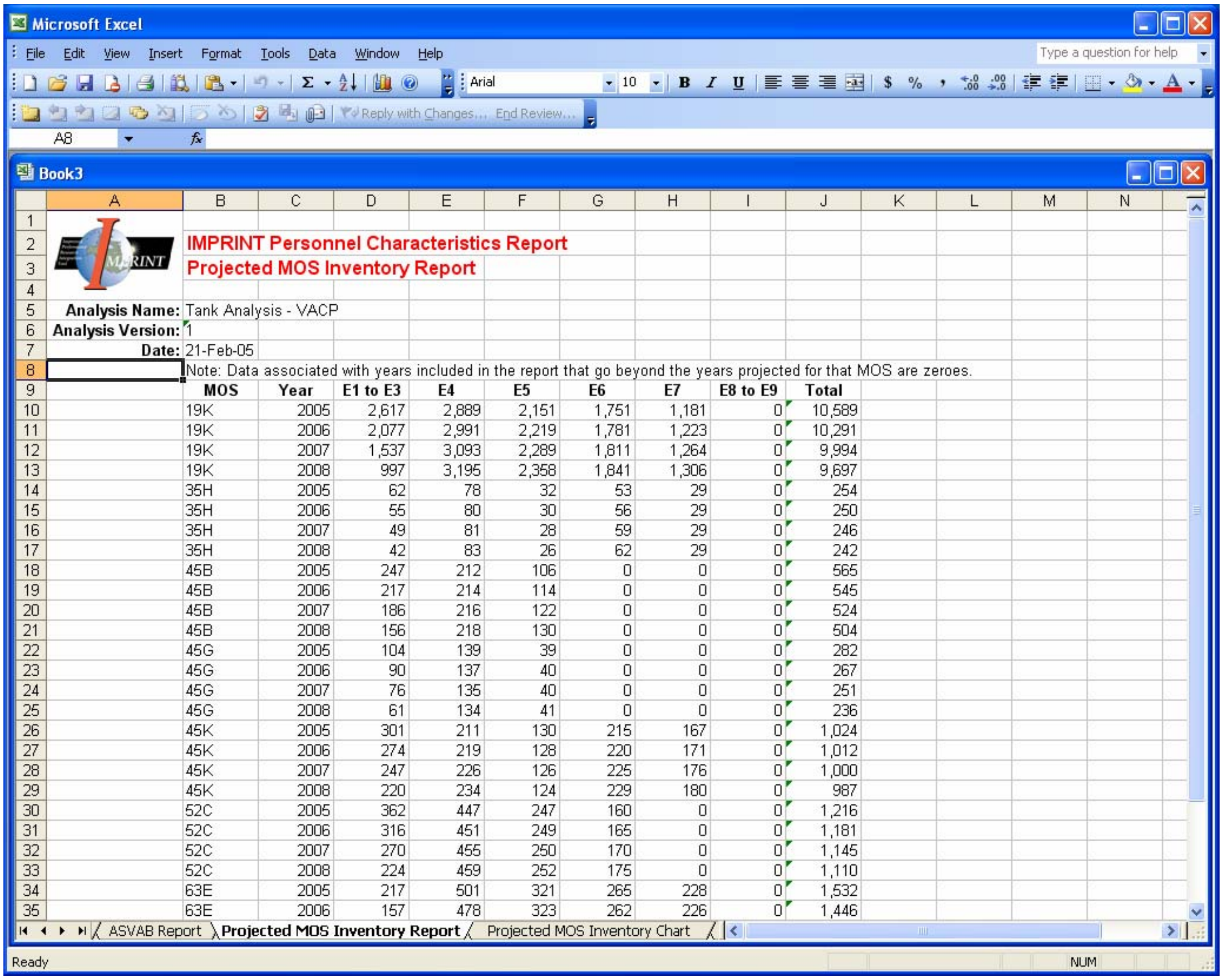


Figure 3-93. Projected MOS Inventory Submenu

Next click the OK button - a Microsoft Excel workbook containing the report in a worksheet is generated as shown in Figure 3-93.



MOS	Year	E1 to E3	E4	E5	E6	E7	E8 to E9	Total
19K	2005	2,617	2,889	2,151	1,751	1,181	0	10,589
19K	2006	2,077	2,991	2,219	1,781	1,223	0	10,291
19K	2007	1,537	3,093	2,289	1,811	1,264	0	9,994
19K	2008	997	3,195	2,358	1,841	1,306	0	9,697
35H	2005	62	78	32	53	29	0	254
35H	2006	55	80	30	56	29	0	250
35H	2007	49	81	28	59	29	0	246
35H	2008	42	83	26	62	29	0	242
45B	2005	247	212	106	0	0	0	565
45B	2006	217	214	114	0	0	0	545
45B	2007	186	216	122	0	0	0	524
45B	2008	156	218	130	0	0	0	504
45G	2005	104	139	39	0	0	0	282
45G	2006	90	137	40	0	0	0	267
45G	2007	76	135	40	0	0	0	251
45G	2008	61	134	41	0	0	0	236
45K	2005	301	211	130	215	167	0	1,024
45K	2006	274	219	128	220	171	0	1,012
45K	2007	247	226	126	225	176	0	1,000
45K	2008	220	234	124	229	180	0	987
52C	2005	362	447	247	160	0	0	1,216
52C	2006	316	451	249	165	0	0	1,181
52C	2007	270	455	250	170	0	0	1,145
52C	2008	224	459	252	175	0	0	1,110
63E	2005	217	501	321	265	228	0	1,532
63E	2006	157	478	323	262	226	0	1,446

Figure 3-94. Projected MOS Inventory Report

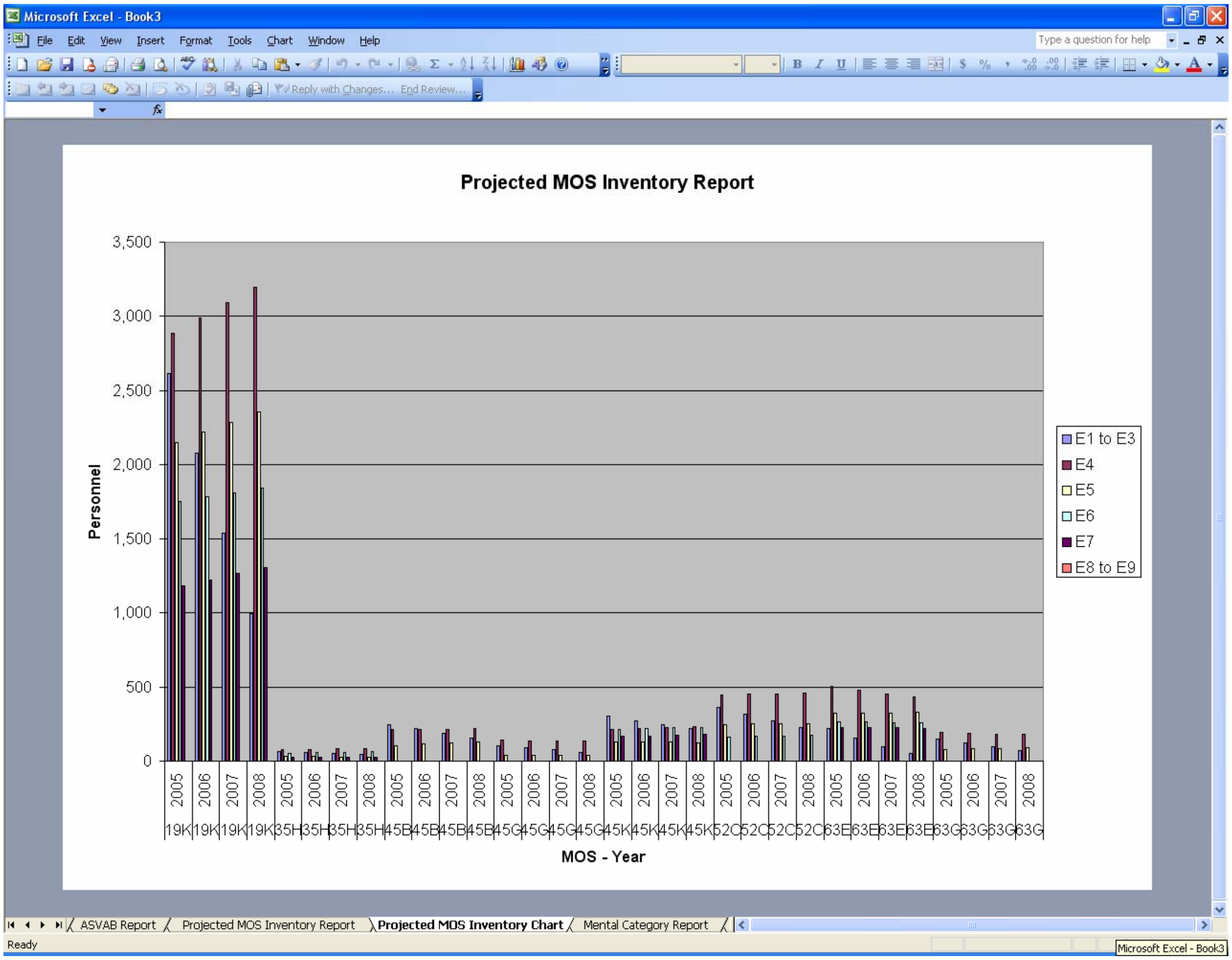


Figure 3-95. Projected MOS Inventory Chart

Force Reports

To create force reports, choose the "Force Results" option from the "Reports" menu. When you make this menu selection, two new dialogs will appear, prompting you to first select a Scenario from a drop-down menu and then to select the reports you wish to generate for that scenario.

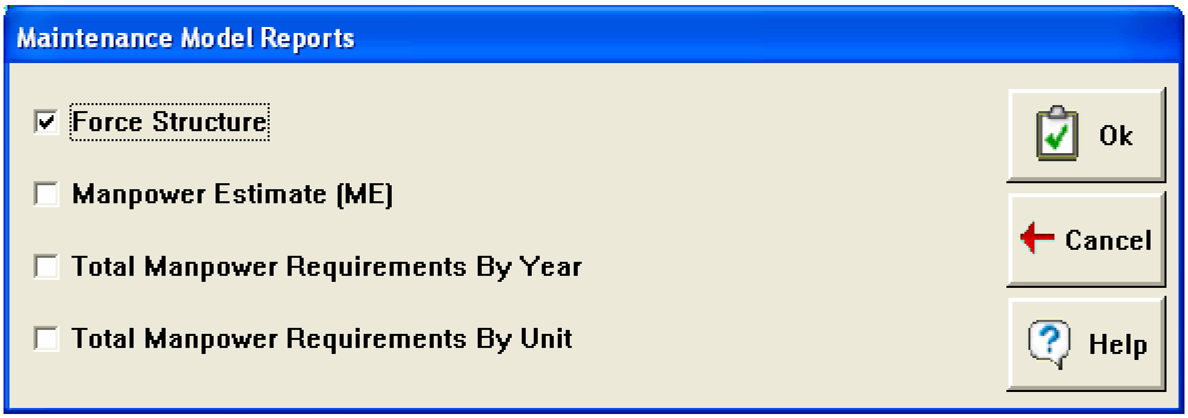
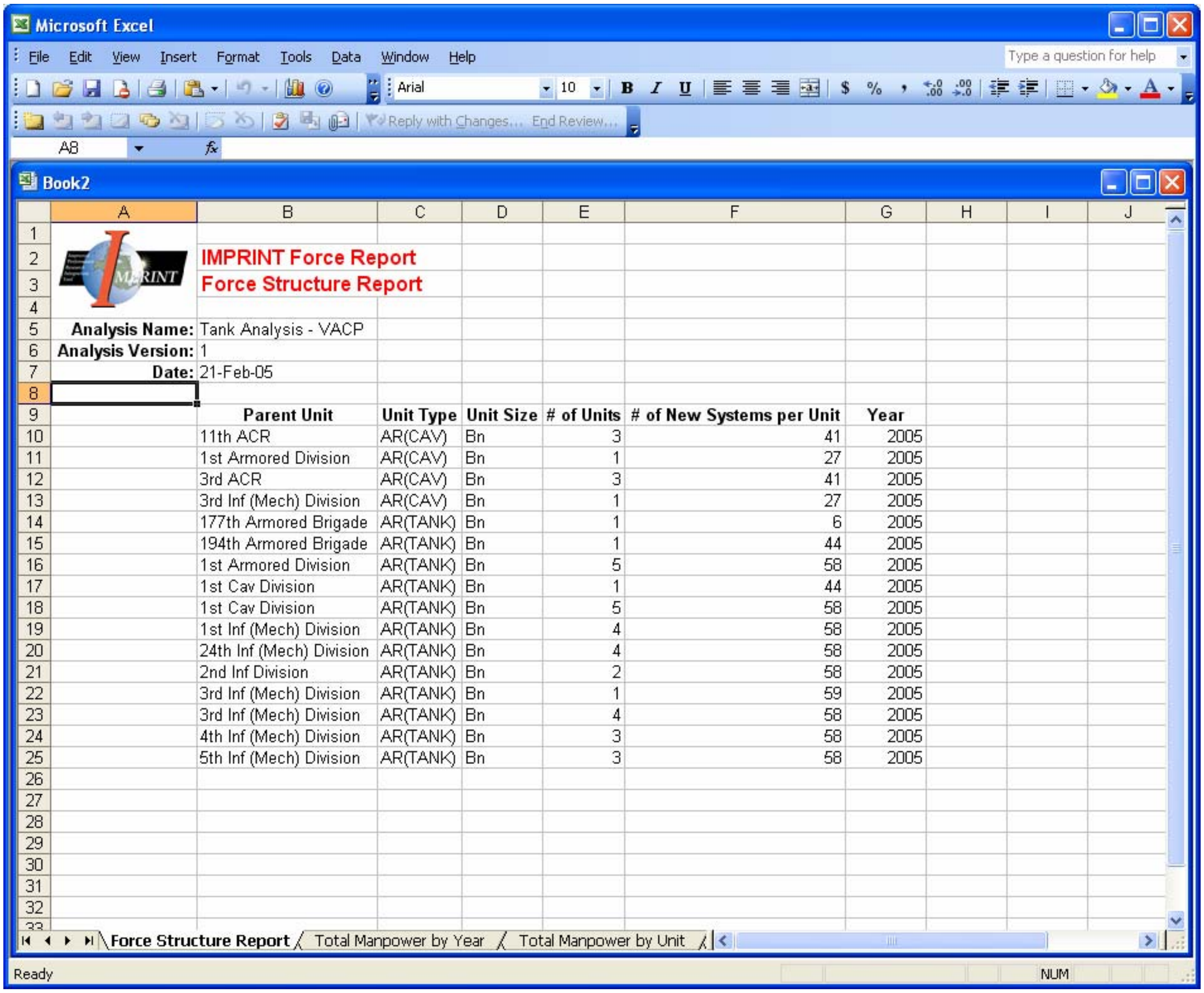


Figure 3-96. Force Model Report Dialog

Choose each report you wish to view by clicking its checkbox to the left.

Finally, click the “Ok” button to generate and display the selected Scenario reports as shown in the figure below. IMPRINT uses Microsoft Excel to generate and display reports:



IMPRINT Force Report
Force Structure Report

Analysis Name: Tank Analysis - VACP
Analysis Version: 1
Date: 21-Feb-05

Parent Unit	Unit Type	Unit Size	# of Units	# of New Systems per Unit	Year
11th ACR	AR(CAV)	Bn	3	41	2005
1st Armored Division	AR(CAV)	Bn	1	27	2005
3rd ACR	AR(CAV)	Bn	3	41	2005
3rd Inf (Mech) Division	AR(CAV)	Bn	1	27	2005
177th Armored Brigade	AR(TANK)	Bn	1	6	2005
194th Armored Brigade	AR(TANK)	Bn	1	44	2005
1st Armored Division	AR(TANK)	Bn	5	58	2005
1st Cav Division	AR(TANK)	Bn	1	44	2005
1st Cav Division	AR(TANK)	Bn	5	58	2005
1st Inf (Mech) Division	AR(TANK)	Bn	4	58	2005
24th Inf (Mech) Division	AR(TANK)	Bn	4	58	2005
2nd Inf Division	AR(TANK)	Bn	2	58	2005
3rd Inf (Mech) Division	AR(TANK)	Bn	1	59	2005
3rd Inf (Mech) Division	AR(TANK)	Bn	4	58	2005
4th Inf (Mech) Division	AR(TANK)	Bn	3	58	2005
5th Inf (Mech) Division	AR(TANK)	Bn	3	58	2005

Figure 3-97. Force Structure Report

Force Structure Report

The Force Structure Report lists all the units that will be getting the new weapon system. It includes the parent unit, the unit type and size, and the number of systems that will be fielded in each unit by year.

The column headings are as follows:

- Org Level - Parent unit of the unit type and size listed (e.g., Division or CORPS)
- Unit Type - Type of unit, such as mechanized infantry or air defense
- Unit Size - size of unit, such as company or battalion
- Units - The number of similar units (as described in the previous column headings) existing in the Army's current Force Structure in which the new system will be fielded
- Systems per Unit - Number of new systems that will be fielded in each unit
- Year - The year in which the new systems will be fielded in the unit(s)

Manpower Estimate (ME) Report

The Manpower Estimate Report is formatted in accordance with DoDI 500.2 which specifies how manpower requirements for a new system are to be documented. The major categories of manpower are operators, maintainers, support, and trainers. Military, civilian and contractor further break out these categories. The cumulative requirements, authorizations, and differences are given for each year until the new system is completely fielded and steady state is reached.

IMPRINT does not provide values for all of the needed categories. Only military operators and maintainers are included.

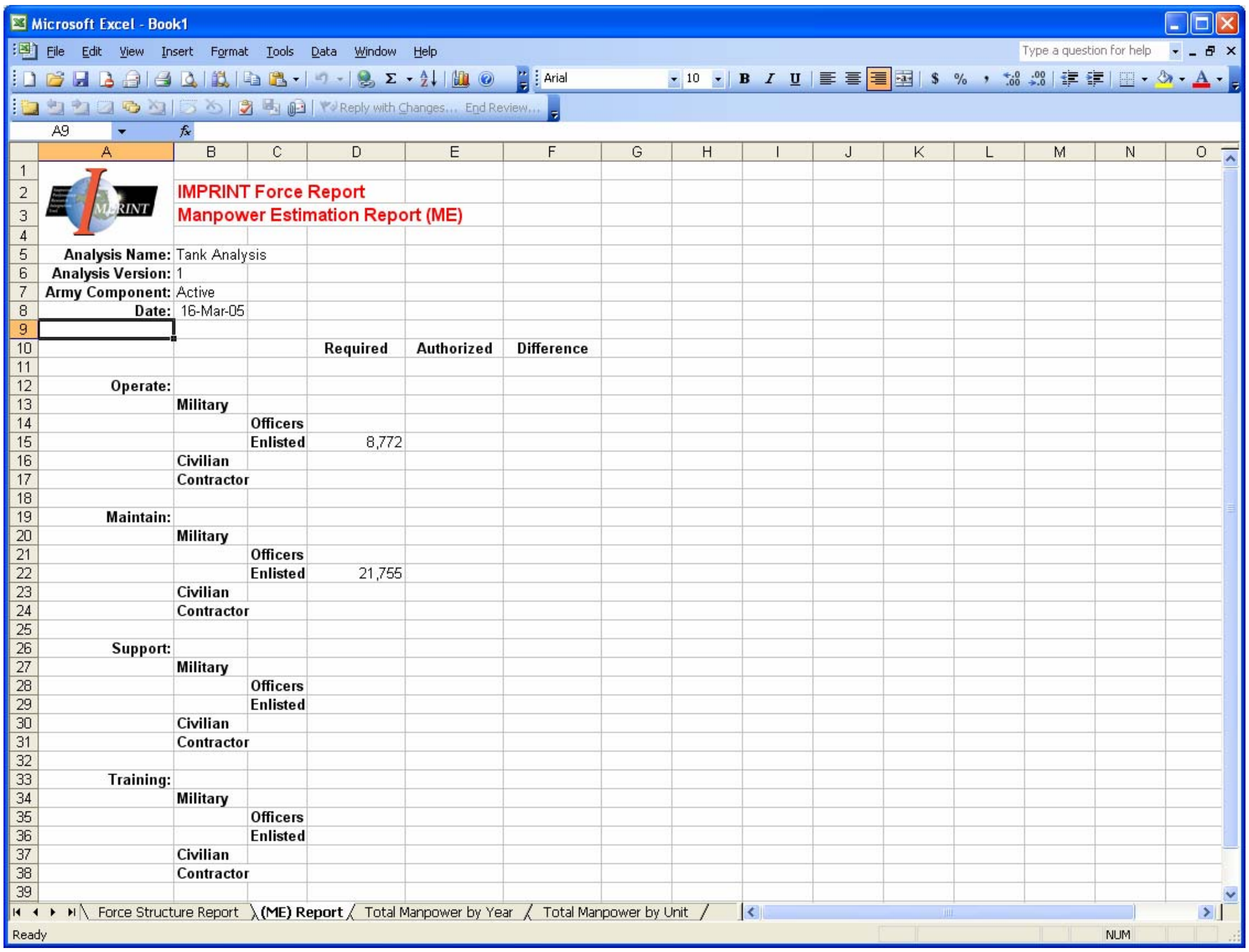
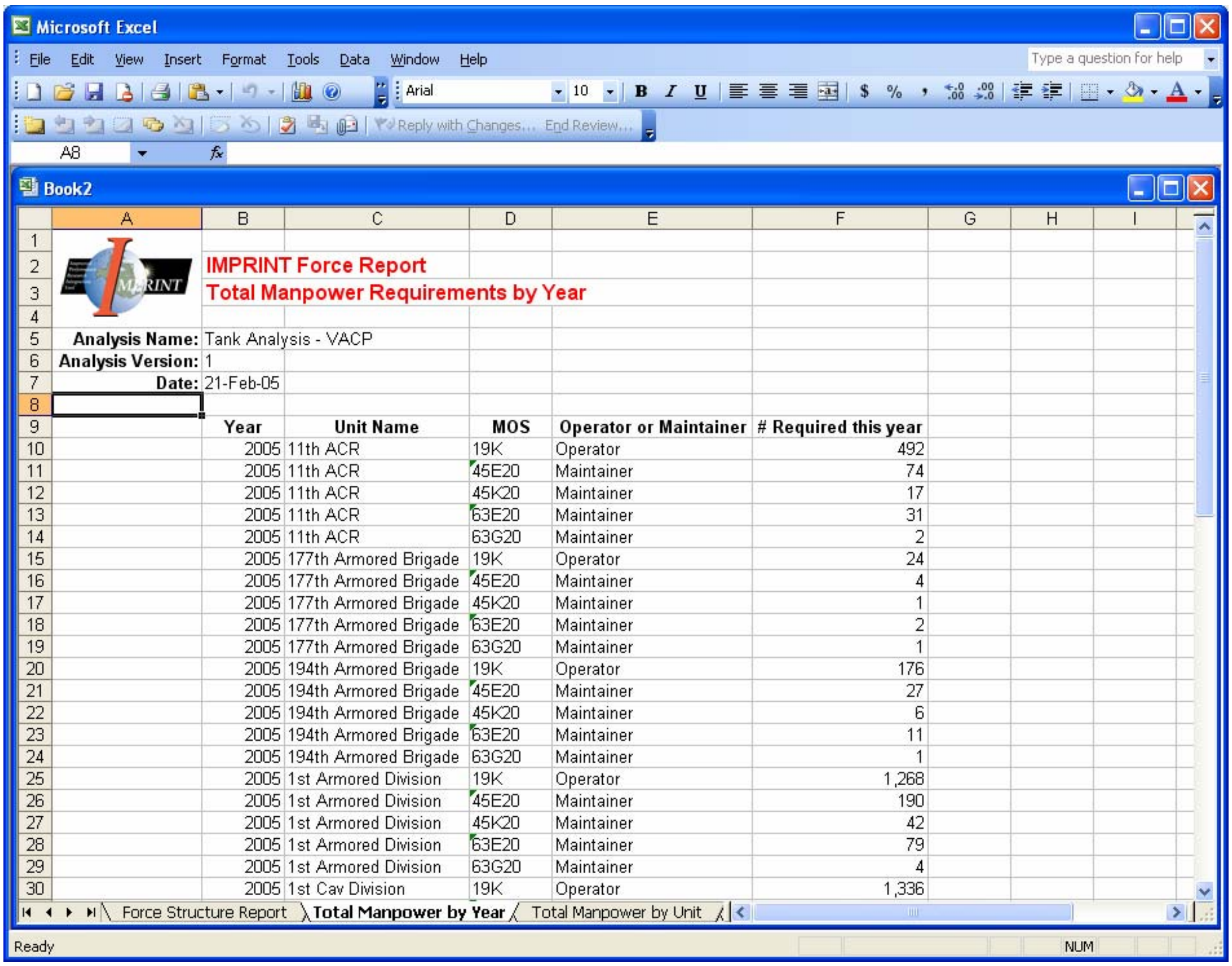


Figure 3-98. Manpower Estimate (ME) Report

Total Manpower Requirements by Year Report

This report lists the total number of operators and maintainers required to support the new system each year. The column headings are:

- Year
- Unit
- MOS (Military Occupational Specialty)
- Operator or Maintainer
- Number required



IMPRINT Force Report

Total Manpower Requirements by Year

Analysis Name: Tank Analysis - VACP

Analysis Version: 1

Date: 21-Feb-05

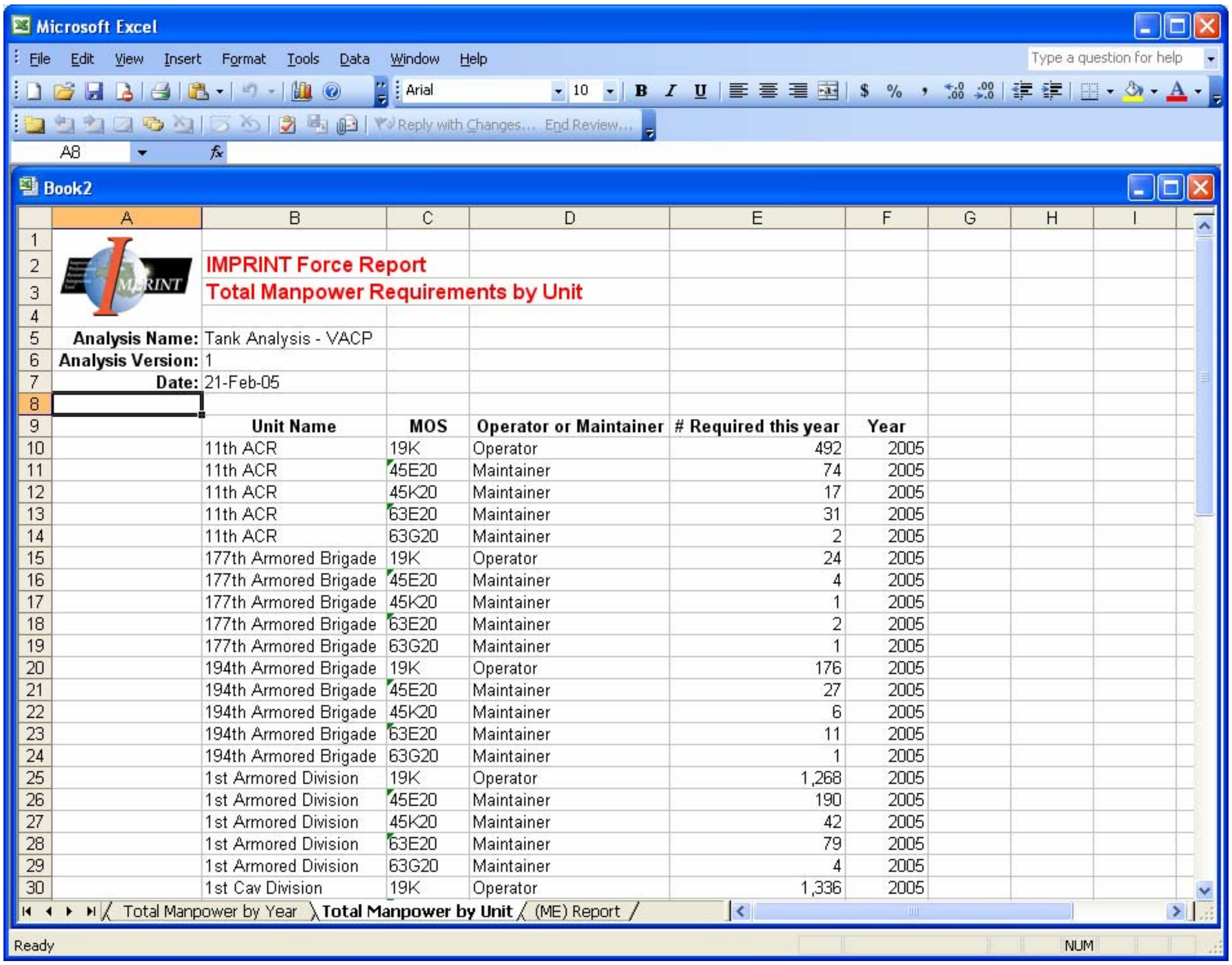
Year	Unit Name	MOS	Operator or Maintainer	# Required this year
2005	11th ACR	19K	Operator	492
2005	11th ACR	45E20	Maintainer	74
2005	11th ACR	45K20	Maintainer	17
2005	11th ACR	63E20	Maintainer	31
2005	11th ACR	63G20	Maintainer	2
2005	177th Armored Brigade	19K	Operator	24
2005	177th Armored Brigade	45E20	Maintainer	4
2005	177th Armored Brigade	45K20	Maintainer	1
2005	177th Armored Brigade	63E20	Maintainer	2
2005	177th Armored Brigade	63G20	Maintainer	1
2005	194th Armored Brigade	19K	Operator	176
2005	194th Armored Brigade	45E20	Maintainer	27
2005	194th Armored Brigade	45K20	Maintainer	6
2005	194th Armored Brigade	63E20	Maintainer	11
2005	194th Armored Brigade	63G20	Maintainer	1
2005	1st Armored Division	19K	Operator	1,268
2005	1st Armored Division	45E20	Maintainer	190
2005	1st Armored Division	45K20	Maintainer	42
2005	1st Armored Division	63E20	Maintainer	79
2005	1st Armored Division	63G20	Maintainer	4
2005	1st Cav Division	19K	Operator	1,336

Figure 3-99. Total Manpower by Year Report

Total Manpower Requirements by Unit Report

This report lists manpower requirements for each unit in the Force Structure that will be getting the new system. The column headings are:

- Unit
- MOS (Military Occupational Specialty)
- Operator or Maintainer
- Number Required
- Year



IMPRINT Force Report

Total Manpower Requirements by Unit

Analysis Name: Tank Analysis - VACP
Analysis Version: 1
Date: 21-Feb-05

Unit Name	MOS	Operator or Maintainer	# Required this year	Year
11th ACR	19K	Operator	492	2005
11th ACR	45E20	Maintainer	74	2005
11th ACR	45K20	Maintainer	17	2005
11th ACR	63E20	Maintainer	31	2005
11th ACR	63G20	Maintainer	2	2005
177th Armored Brigade	19K	Operator	24	2005
177th Armored Brigade	45E20	Maintainer	4	2005
177th Armored Brigade	45K20	Maintainer	1	2005
177th Armored Brigade	63E20	Maintainer	2	2005
177th Armored Brigade	63G20	Maintainer	1	2005
194th Armored Brigade	19K	Operator	176	2005
194th Armored Brigade	45E20	Maintainer	27	2005
194th Armored Brigade	45K20	Maintainer	6	2005
194th Armored Brigade	63E20	Maintainer	11	2005
194th Armored Brigade	63G20	Maintainer	1	2005
1st Armored Division	19K	Operator	1,268	2005
1st Armored Division	45E20	Maintainer	190	2005
1st Armored Division	45K20	Maintainer	42	2005
1st Armored Division	63E20	Maintainer	79	2005
1st Armored Division	63G20	Maintainer	4	2005
1st Cav Division	19K	Operator	1,336	2005

Figure 3-100. Total Manpower by Unit Report

Adjust Menu

Workload Overload Reassignment

You can use the Workload Overload Reassignment option under the “Adjust” menu item to reassign tasks that were performed during points of VACP workload overload. If you choose the “Auto” option, shown in Figure 3-102, IMPRINT will attempt to reassign tasks that caused a crewmember to go into an overload condition, but assigning them to a secondary operator. If you have not assigned secondary operators, or if none of your secondary operators can accept the task without also going into overload, then IMPRINT will report this. Once IMPRINT identifies a workable reassignment, you can either accept or reject the recommendation.

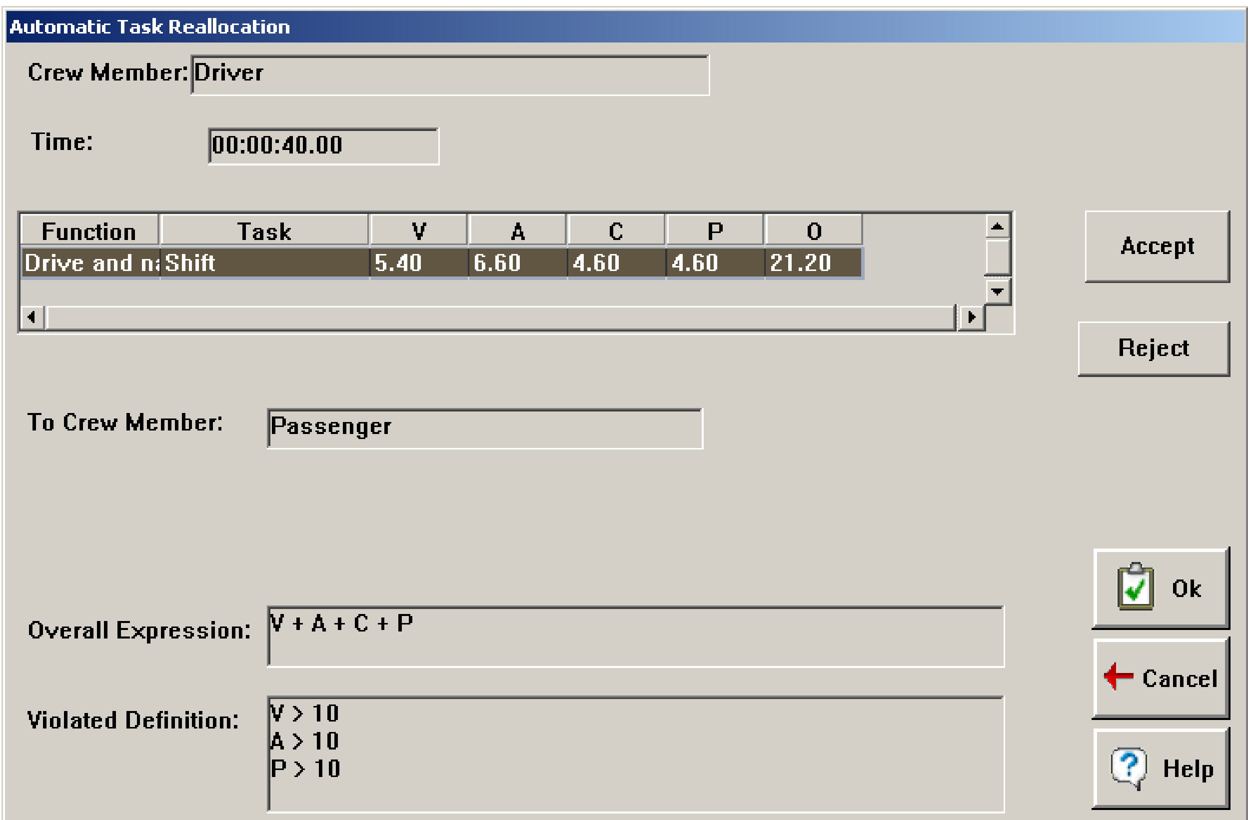


Figure 3-101. Auto Task Reassignment

If you choose the “Manual” option, then IMPRINT provides you a list of the tasks that were being performed in parallel by an operator during each point of workload overload. This is shown in Figure 3-102. The VACP scores of each task are also included. At the bottom of the interface, IMPRINT tells you what the overall expression evaluated to at this time, and which work overload definitions were violated.

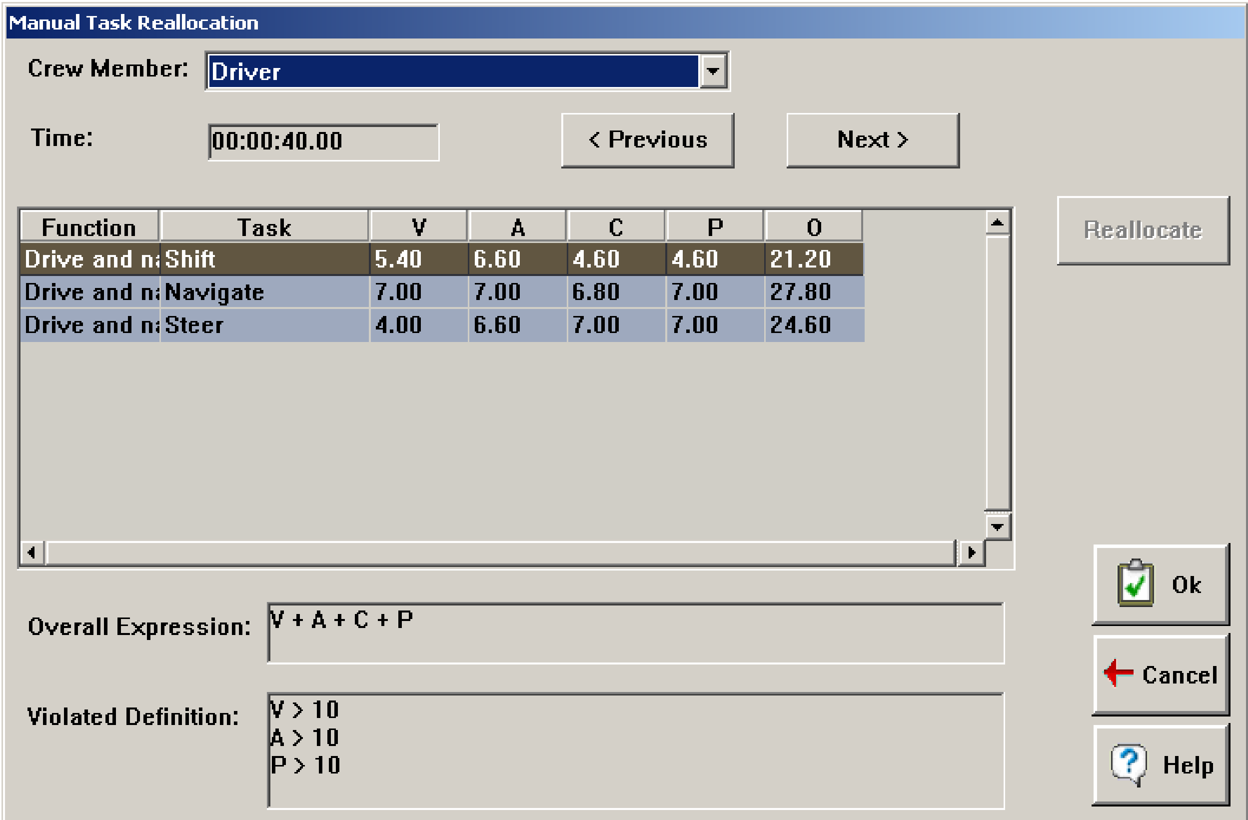


Figure 3-102. Manual Task Reallocation

To reassign one of the tasks, you must have first identified secondary operators for the selected tasks. If you have not identified secondary operators, IMPRINT will remind you of this. You can either attempt to reallocate a different task, or you can return to the define mission portion of IMPRINT and assign secondary operators. Then, you will have to re-execute your mission before adjusting for overload.

After you have moved through all the points of overload, using the “Next “and “Previous” buttons at the top of this screen, you must re-execute your mission to ensure that overloads have been alleviated. Additionally, it will be important that you change the random number seed and run it several more times to provide your tasks an opportunity to sample from the distribution of times, accuracies and branching logic. A different random number seed may actually trigger different overload points.

Chapter 4 - Overview of the IMPRINT Operations Model

The purpose of this chapter is to describe the process that is followed when you execute an IMPRINT Operations Model.

To begin execution of the model, go to the Execute menu and select the Operations Model… option. Next, in the window that appears, click on the “Run Model” button. When the model begins, the first thing that happens is that the data in your analysis database will be used to compile a file (named imprint.mod) that is formatted so that Micro Saint can execute it. Then, Micro Saint is started and the execution will begin to process the data file. If you have checked the Animation option, you will see the Micro Saint task network display.

The Micro Saint engine begins by attempting to process the very first task in your task network that follows the 0 (Start) function. If there is a function following the 0 function, then it will begin with the first task of that function. All the parameters associated with a task are then processed in order.

Step 1 - Evaluate the Release Condition - The first thing that it does when it starts running is it makes sure that the release condition evaluates to non-zero (i.e., is ok to start). In a VACP model, you cannot directly edit a Release Condition. They are automatically generated based on your rejoin data. In an Advanced Mission, you can enter Release Conditions directly. Also, in an Advanced Mission, a portion of the Release Condition is automatically generated. Its purpose is to determine whether the beginning of this task would put the assigned operator into overload. If it will put the operator into overload, then the appropriate workload management strategy is implemented (e.g., the task is reassigned to a different operator, is not started, is dumped, or the performance is penalized). If the Release Condition evaluates to non-zero and the overload information calculates acceptably, then Micro Saint proceeds to the second parameter.

Step 2 - Calculate a task performance time - In this step, Micro Saint pulls a random number out of the generator and uses that number, along with the Mean Time, the Standard Deviation, and the Distribution, to calculate a precise task time for this occurrence of the task. It will add this time to the current simulation time, and use that to schedule the completion of this task. If task performance time is being penalized (either because of Personnel Characteristics, Training Frequencies, and Stressor (PTS) settings or because of overload or failure consequence penalties), then this adjustment is included.

Step 3 - Micro Saint executes the task’s Beginning Effect - In a VACP model, you cannot enter a Beginning Effect. Rather, it is generated automatically, and performs calculations that assign the task to the operator you have chosen, and increments the workload values associated with the task. If you are executing an Advanced Mission, then any expressions you have entered are also executed.

Step 4 - Begin the task - Then the task will be highlighted on the Micro Saint Animated task network, and it will become active.

Step 5 - Task interruptions - In an Advanced Model, a task can be interrupted because a higher priority task needs to begin. In this event, Micro Saint records the amount of time that the task has already been executing. If the task is going to be resumed, then Micro Saint adjusts the performance time to account for the fact that some time has already been expended. If the task is going to be restarted, then Micro Saint recalculates a new performance time that will be used when the task is restarted.

Step 6 - Task completion - Once the appropriate amount of time has passed in the simulation, the task's scheduled time for completion will occur. When this happens, the first thing that Micro Saint does is process the task's Ending Effect. In a VACP mission, the Ending Effect is generated automatically. It adjusts the current workload values and makes the operator available. In an Advanced Mission, these automatic calculations are done, and then any Ending Effect that you have entered is performed.

Step 7 - Evaluate Accuracy - Next, Micro Saint uses the random number generator and compares the result against the task's probability of success to determine whether the task succeeded or failed on this particular occurrence. If you selected Adjustments, and have adjusted the task accuracy for PTS effects, the new "adjusted" task accuracy will be used. Otherwise the task accuracy that you entered on the Task Information dialog will be used. If the task failed, then the failure consequences are evaluated. If the task succeeded, then we skip the next step.

Step 8 - Evaluate Failure Consequences - If a task failed to meet its accuracy standard, then Micro Saint draws another random number to determine which Consequence of Failure should be implemented. The random number is compared to the distribution of Failure Consequences you entered. The appropriate consequence is then implemented. If the Failure Consequences changes the following task, then the next step is skipped, and that task is started, using the same procedure described in the previous steps. If the failed task has a Failure Consequence where another task follows it, and that task is the same task (i.e., you repeat the task in the event of failure), then each occurrence is counted separately.

Step 9 - Select following tasks - If the task has completed normally, then the decision type is evaluated to determine which following tasks could be started. If there is more than one following task (i.e., multiple decision), then each task is started in the order in which it is listed on your IMPRINT decision branching dialog. Each task is started and processed using the same procedure described in the previous steps.

This procedure continues until no more tasks are executing. The mission, function and task performance reports include records of the number of times each task occurred, as well as the minimum, maximum, mean and standard deviation of the performance time. Also, the task performance report includes a record of the percentage of times that the task failed to be performed accurately. The function performance time is calculated by subtracting the time at which the first task in the function began from the time that the final task in the function completed. The mission performance time is calculated by recording the time that the final task in the model completed. Mission performance accuracy is calculated by recording the total number of times that the mission was executed. It is then compared to the number of times that the mission was aborted because a task with that particular failure consequence failed.

The process we have described is a standard process for discrete event simulation tools. For further information, we recommend that you refer to a discrete event simulation textbook.

Chapter 5 - Overview of the IMPRINT Maintenance Model

The purpose of this chapter is to describe how the maintenance analysis works. We recognize that this is a very technical topic, however, we have attempted to simplify it as much as possible. We expect that the reader will have some understanding of discrete event simulation modeling, however we do not expect the user to understand Micro Saint syntax. Additionally, we expect that the user will be very familiar with the terms used on the IMPRINT screens for the Define Equipment portion of the tool.

So how does the maintenance model really work?

The maintenance model is composed of three pieces.

1. Metbase.mod is the base Micro Saint model. It is a “canned” model that represents the way that systems and components will flow through maintenance. It contains the task network for the maintenance model. It is static, in that user entries do not have an effect on the content of this file. The metbase.mod file will not run by itself. It is an ASCII text file and has a very specific format. You should not edit this file. If this file is deleted, IMPRINT cannot execute the maintenance model and will return a “missing metbase.mod file” error.

2. Metbase.evt is the file of user data from the IMPRINT database. It is generated when the user pushes the “Run” button from the Execute Maintenance Model interface. This file is generated in the form of Micro Saint Scenario Events. It will not execute in Micro Saint by itself. It is an ASCII text file and has a very specific format. You should not edit this file.

3. Inserting the metbase.evt file into the middle of the metbase.mod file generates Met.mod. IMPRINT performs this operation immediately after it generates the metbase.evt model, and immediately before it tells Micro Saint to begin executing the new met.mod model. This ASCII text file is in a very specific format, and should not be edited by a user. The Met.mod file defines the data that drives a discrete event task network simulation model.

How is Micro Saint started?

A specially developed run-time version of Micro Saint is started using a command line argument from IMPRINT. This will tell Micro Saint to run in the background, and will tell it to execute the met.mod data file. Finally, it will turn on the data collection capabilities.

How does the Analysis Flow?

The figures below are the task networks that reside in metbase.mod, and are then incorporated into the met.mod that is executed by Micro Saint.

While the logic involved in making the model run is quite complex, we will provide a basic overview here.

The maintenance analysis model can be thought of as having three separate, but interrelated parts. The first part, shown in Figure 5-1, controls the flow of systems into mission segments. In this part of the model, the entities flowing through the network represent individual systems (e.g., tanks, helicopters). This part of the model controls the accrual of usage to each individual component of each system (based on the distance traveled, rounds fired, and time operated). It also predicts any combat damage. Before sending a system out to perform a mission segment, IMPRINT "looks ahead" to see whether the mission segment will be aborted due to a failure of a critical component. If it determines that the mission segment will be aborted, it is careful to accrue only the completed proportion of usage to all components in that particular system. When the system returns from a mission segment, each non-abort component in each system is checked to determine whether the accrued usage is greater than the failure clock. It is important to note the amount of fidelity that is represented in the model. IMPRINT tracks separate failure clocks for each maintenance action (i.e., combination of repair task and component) on each system.

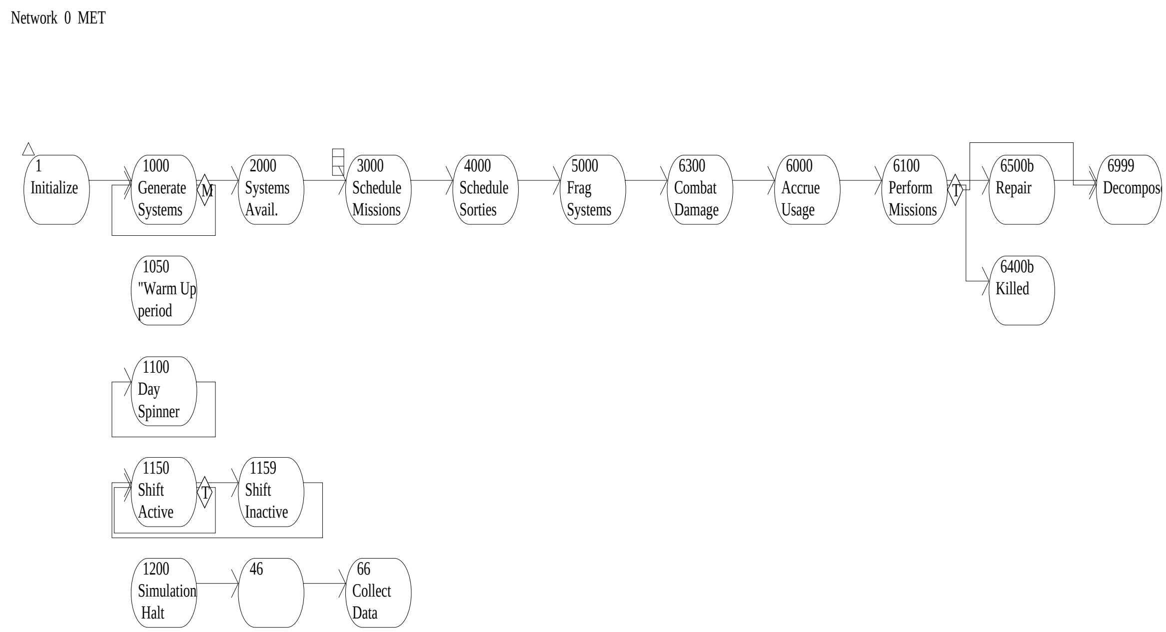


Figure 5-1. Part 1 of Met.Mod

For any system that now has any components that are in need of maintenance, the parent system is removed from the "systems available" pool, and the maintenance actions are sent to the second part of the model, depicted in Figure 5-2.

There are also some bookkeeping tasks in Part 1. These are used to maintain statistics by the day and by the shift.

In Part 2 of the model, the maintenance actions are performed. In this portion of the model, the entities flowing through the network represent maintenance actions. Maintenance actions are queued up in front of their respective organizational levels. If the maintenance action is "remove and replace" and the maintenance task is marked as a "Crew Chief" task, then the spare parts parameters for the parent subsystem are examined to see if the spare is actually needed, and if so, whether it is available. If it is not available, the system repair is not routed to the Crew Chief for maintenance but is routed to its default maintenance organization and is delayed for the appropriate time needed to procure the spare.

If a maintenance action has been marked for “contact team” maintenance, then the contact team “capacity” is assessed to determine whether there is sufficient room in the contact team queue for the new maintenance action. If sufficient capacity is not available, as specified on the contact team GUI, then the maintenance action is routed to the selected organization level.All organizational maintenance for an individual system must be completed before direct support maintenance begins for that system. Similarly, all direct support must be completed for that system before any general support maintenance can begin. The queues associated with each organizational level are sorted by a fairly complex strategy.

All organizational maintenance for an individual system must be completed before direct support maintenance begins for that system. Similarly, all direct support must be completed for that system before any general support maintenance can begin. The queues associated with each organizational level are sorted by a fairly complex strategy.

The total predicted maintenance time for each system is estimated by summing the mean times to repair for all the tasks of a specific system. The maintenance actions are then placed in an initial order that gives priority to the system with the shortest estimated total maintenance time. Then, the manpower requirements of the maintenance actions in the queues are compared to the available manpower pool (by Military Occupational Specialty (MOS), skill level) for each organizational level. The maximum number of tasks that can be released are then sent into the tasks where maintenance is performed. This strategy is careful to keep maintenance actions from being “holed.” This means that if a maintenance action takes fewer maintainers than one that is above it in the queue, and insufficient maintainers are available to process the high priority action, the lower priority task will be released.

One final issue associated with this process is that all maintenance actions that are not complete at the end of a shift will be interrupted until enough maintainers are available on the next manned shift in order to complete the action. Maintenance actions that are interrupted are always given a higher priority than actions that have not yet begun.

When all maintenance actions for a particular system are complete, the system is “reconstituted” and sent back to the system available pool. It is then available to be assigned to any upcoming mission segments.

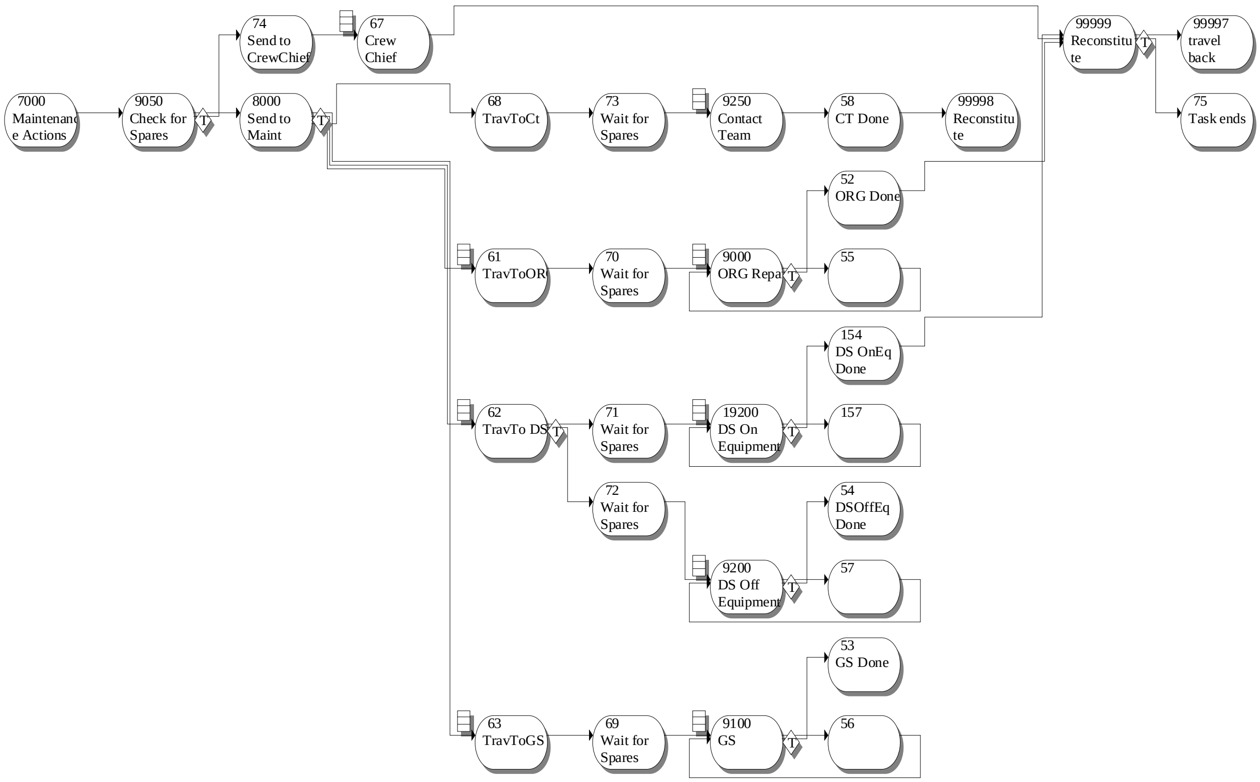


Figure 5-2. Part 2 of Met.Mod

Part 3 of the model runs in parallel to the first two parts. In this part, the entities flowing through the network represent mission segments. The purpose of this portion of the model is to schedule mission segments and to determine whether they should be released or canceled. Mission segments are released if there are enough systems in the available pool to meet the minimum number required at the mission start time. If the mission segment is not filled to its minimum at that time, the model continues to try to gather enough available systems by the mission cancellation time. If enough systems are not available at cancellation time, the mission is canceled and all systems are returned to the available pool.

The scheduler uses the mission segment priority to determine which mission segment systems will be assigned to if more than one segment is scheduled to leave at the same time. If this happens, then the model will attempt to fill each mission segment's minimum, before filling the mission segment to the maximum.

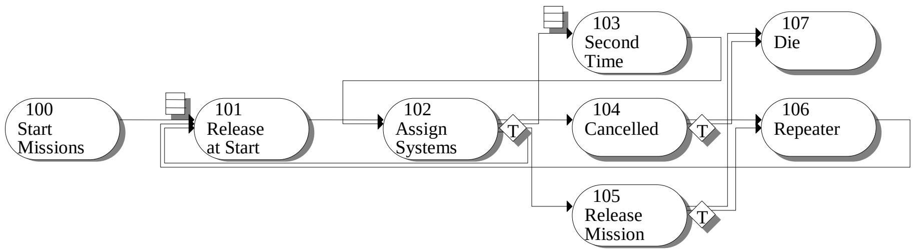


Figure 5-3. Part 3 of Met.Mod

How are the results of the model collected?

The results of the model run are gathered in two ways. There are some customized functions built into this version of the Micro Saint run time engine that collect values of variables that are calculated within the model. Also, several Micro Saint snapshots have been defined that are used to collect results. All the results are stored in your IMPRINT directory in files with a ".res" extension. These are ASCII text files that can be opened by other applications (e.g., MicroSoft Excel). We do not recommend that you use this method of examining your results. IMPRINT does take the results from your Micro Saint .res files and stores them in your IMPRINT database. These results are then accessible through the Maintenance Models option on the IMPRINT Reports menu pull-down.

Chapter 6 - Error List

There are several different classes of errors. These include errors that are from IMPRINT, from the IMPRINT databases, from the Crystal Reports report generator, and from the Micro Saint simulation engine. Errors can mean that you have a specific problem with your analysis, that there is a problem with your computer system (e.g., insufficient memory, insufficient storage capacity, inconsistent Dynamic Linked Library (DLL) setups). In the table below, we describe the text of the error, the type, and how to respond to the error. If you encounter an error that is not in this table, and you do not know how to respond, please contact IMPRINT technical support.

TEXT	TYPE	WHAT TO DO
A semi-colon is required at the end of beginning effects	IMPRINT error message	You have entered a task beginning effect on the Effects tab of the Task Information screen. All expressions must be terminated with semi colons. For more information regarding the correct syntax for the expressions, please refer to the IMPRINT User's Manual.
A semi-colon is required at the end of ending effects	IMPRINT error message	You have entered a task ending effect on the Effects tab of the Task Information screen. All expressions must be terminated with semi colons. For more information regarding the correct syntax for the expressions, please refer to the IMPRINT User's Manual.
A semi-colon is required at the end of release conditions	IMPRINT error message	You have entered a task release condition on the Effects tab of the Task Information screen. All expressions must be terminated with semi colons. For more information regarding the correct syntax for the expressions, please refer to the IMPRINT User's Manual.
All task operators must have a resource/interface channel assigned before the model can run. Operator XXX does not for task XXX.	IMPRINT error message	You have attempted to execute an Advanced Workload model, but you have not assigned channels to tasks. You must return to the Options menu, select the Workload and Crewstation Parameters item, and enter these data.
Error Reading Data	Database error message	IMPRINT was not able to read your data. This might be because you opened this analysis with a more recent version of IMPRINT than you are now using. Your

		analysis database could also be corrupted. We recommend that you contact technical support.
Error Saving Analysis	IMPRINT error message	IMPRINT was not able to save your analysis. This is probably because your disk is full, but could also be because something in your analysis is corrupted. If you are unable to save after making sure you have at least 10 MB available on your disk, please contact technical support BEFORE you turn your PC off.
Error Writing Data	Database error message	IMPRINT was not able to write your data. This might be because you have duplicate records in your data. There is nothing you can do to fix this, and we recommend that you contact technical support immediately.
Every task must have at least one operator assigned to it. This task does not: XXX	IMPRINT error message	You have attempted to execute an Advanced Workload Model, but all the tasks have not been assigned to operators. You must return to the Oper Assgn tab on the Task Information screen and assign an operator to each task.
Force data are not available for this system	IMPRINT information message	You attempted to Define the Force Structure of your system, but you have not defined a maintenance scenario. You must Define Equipment and add a scenario before you can Define the Force Structure.
General Protection Fault (GPF)	IMPRINT error message	This is a critical and catastrophic failure. It is typically caused by insufficient Random Access Memory (RAM). You will have to reboot your system to recover. You should then make sure that you have at least 32 MB of RAM available on your system. If you have lost any data, refer to the "Autosave" feature in order to recover. If you do not have sufficient RAM, you may have to upgrade your system.
In order to adjust for Workload Overload, you must first run the operations model from the Execute menu.	IMPRINT information message	You have accessed the Workload Overload item on the Adjust menu before executing the operations model that you have open. You must first execute this model by choosing the Operations Model item on the Execute menu.
In order to copy	IMPRINT	You are attempting to duplicate functions

functions, you must first open a mission in Define System Mission	information message	from one mission to another without having opened a mission into which the functions would be copied. Click on the OK button, then return to the mission tab and select a mission.
In order to generate a report, you must first run the projection model.	IMPRINT information message	You have attempted to display a report that does not contain data. You must go to Define Soldiers and run the projection model before you can display this report.
In order to print this report, you must first run the Maintenance Model from Execute for the scenario you selected.	IMPRINT information message	You attempted to display a Force Report, but you have not executed the maintenance scenario model that you selected. Return to the Execute menu and run the maintenance model.
Invalid Record Format; Import Aborted	IMPRINT error message	You attempted to import or append data to your analysis, and the import file you selected is in an improper format. Click on the OK button, then select a file that is of the correct format. For information on the proper format for Append task files, please refer to the appropriate topic in the IMPRINT User's Manual.
Model Generation Failed	IMPRINT error message	IMPRINT attempted to generate an Advanced Mission model but was unable to complete this operation. Most likely, this is because you are missing some of the necessary data files from your directory. Go to your IMPRINT directory and make sure that basevar.dat, opervar.dat, taskvar.dat, and funcinfo.dat are present. If they are not, contact technical support for replacement files. If these files are present, make sure that your hard disk has sufficient space available. You should have at least 10 MB free.
Negative mean time in job XXX	Micro Saint error message	This error indicates that the model generated by IMPRINT that Micro Saint is attempting to execute is corrupted. Please contact technical support.
No Operator or Maintainer MOS's exist	IMPRINT information message	You have attempted to access the PTS option on the Options menu, but you have not defined any soldiers for your system. You can not apply personnel characteristics, training frequencies, or stressor adjustments until you have defined soldiers. You must return to the Soldiers option on the Define menu and complete this operation.

No tasks found for MOS. Taxons must first be assigned.	IMPRINT information message	You have attempted to access the PTS option on the Options menu, but you have not assigned Taxons to your tasks. You can not apply personnel characteristics, training frequencies, or stressor adjustments until you have assigned your taxons to your tasks. You must return to the Task Information dialog, choose the Taxons tab, and assign values.
Not a unique name	IMPRINT error message	You have attempted to duplicate a data item without entering a unique name. Click on the OK button, then return to the duplicate command and enter a unique name.
ODBC access resulted in error. Database access error.	Database error message	IMPRINT was not able to open your databases. This could be because some of your .db files have been moved or deleted. You should have IMPRINT.db, cleandb.db, director.db, and template.db in your IMPRINT directory. Click on OK. Make sure these files are where they should be. If they are not, you may need to reinstall IMPRINT. We suggest you contact technical support.
Save current analysis before closing it? If you choose not to save, all changes made in this session will be lost	IMPRINT information message	Click on the Yes button to save, the No button to cancel changes and exit, and the Cancel button to cancel the current command and return to IMPRINT.
Save your diagrams with their task and function information?	IMPRINT information message	You are exiting from the network diagram and you have made some changes. IMPRINT is asking if you want to save the new network layout. If you click on Yes, the information will be saved. If you click on No, the changes will be canceled. If you click on Cancel, you will be returned to the network drawing. NOTE: THIS DOES NOT REPLACE THE NEED FOR YOU TO PERFORM A SAVE COMMAND ON THE FILE MENU. We recommend that you use the save command on the file menu often.
Task can never be released	Micro Saint error	This error was caused by a problem with either your rejoin tasks (if you have a VACP mission) or with your Release Conditions (if you are executing an Advanced Mission). If you have a VACP mission, return to the network diagram

		and study each of your multiple decisions to make sure that the rejoin task is correct. For more information, refer to the IMPRINT User's Manual. If you have an Advanced Mission, a task can not released until its Release Condition evaluates to a non-zero value. For more information on writing Release Condition expressions, please refer to the IMPRINT User's Manual.
SQL Error 100	Database error	Database not found. Please make sure that IMPRINT.db, Anal001.db, Cleandb.db and Template.db are all in your IMPRINT directory.
SQL Error 101, 102, 103, 104, 200, and 400	Database error	Database cannot convert. Please make sure that the correct versions of IMPRINT.db, Anal001.db, Cleandb.db and Template.db are all in your IMPRINT directory.
SQL Error –80 through -89	Database error	Unable to correctly start database engine. Often caused by a lack of available resources or memory. Attempt to recover memory by leaving IMPRINT and rebooting your computer.
SQL Error –99 through -109	Database error	Unable to connect to the database properly. Please make sure that IMPRINT.db, Anal001.db, Cleandb.db and Template.db are all the most recent versions.
SQL Error –110 through –119, -125 through –128, -250, -251, --183	Database error	Unable to create the specified data element in the database. Please make sure that IMPRINT.db, Anal001.db, Cleandb.db and Template.db are all the most recent versions.
SQL Error –120 through -123	Database error	Database permission errors. Contact your system administrator to check the permission parameters on the IMPRINT database files.
SQL Error – all other error codes	Database error	Database access errors. Please report these errors to technical support.
The system has no scenarios so there is nothing to run	IMPRINT information message	You have attempted to Execute a maintenance model, but you have not entered any maintenance scenarios. You must return to Define Equipment and enter a scenario before you can execute the model.
The total task accuracy probability = xx. It must = 100.	IMPRINT error message	All of the percentages for the failure consequences on the Task Information tab must sum to 100 before you can save your results or leave the tab. Click on

		OK and then correct the values so that they sum to 100.
The Total Weight = x. It must = 1.0 or 0.0.	IMPRINT error message.	The weightings attached to the taxon categories on the Taxon tab of the Task Information screen must sum to either 1.0 or 0.0 before you can save your results or leave the tab. Click on OK and then correct the values so that they sum to 1.0 or 0.0.
There are no secondary crew members for any overloaded tasks	IMPRINT information message	You are attempting to reallocate tasks under the Adjust menu because you have points of overload in your mission. Unfortunately, you did not identify any secondary operators for the tasks that are contributing to overload, so there is no one to whom IMPRINT can reassign any of the troublesome tasks. You must return to the Crew Assgn tab of the Task Information dialog to identify secondary operators. You may have to add them to your Crew first (through the Crew button on the Mission Information screen) if you only have one operator in your analysis.
This analysis name and version already exists	IMPRINT error message	Click on OK and then enter a different analysis name or analysis version.
This file cannot be found. Make sure that you have specified the correct path and filename	IMPRINT error message	You have attempted to import a file that is not in the directory that you have entered. Click on the OK button and then use the browse capability to find the file you need.
This file type does not match the format you chose on the previous dialog box	IMPRINT error message	You are attempting to import data from LSA into IMPRINT. The format of the file you have selected is not what IMPRINT expects for the LSA version you have selected. If you are certain that the format is correct, review the IMPRINT User's Manual to make sure that the font and file layout are acceptable. If you still can not resolve the problem, contact technical support.
This option maps workload scales to task taxons for operator and maintainer tasks. Do you want to continue?	IMPRINT information message	You have chosen to map workloads to taxons. This will overwrite any existing taxon data with new values. This operation is not reversible. If you want to continue, click on Yes. If not, click on No.
This version of IMPRINT requires ALL functions at the	IMPRINT information message	This message is a reminder that Advanced Workload missions are limited to two levels in the task network. The top

top level and ALL tasks below them to generate a correct model		level must be composed of just functions, and the second level can only have tasks, in order for the model to run correctly. VACP missions can have tasks and functions mixed on any level and are not restricted to only two levels. Click on the OK button, and make sure that your mission layout is consistent with this requirement.
Time format HH:MM:SS.dd expected	IMPRINT error message	You have entered a time value in an improper format. The correct format is HH:MM:SS.dd. All the digits must be numerical. Click on the OK button and correct the error.
Unable to open source file	IMPRINT error message	IMPRINT was not able to open a file you selected. This is either because the path you chose is incorrect, or because the file is corrupted. If you are sure the path is correct, attempt to open another analysis. If you succeed at opening another analysis, your selected file is not properly formatted. If you cannot open another analysis, check to see whether there is sufficient room on your hard disk. You should have at least 10 MB available. If you still can not open the file, contact technical support.
You have chosen to perform an advanced workload analysis. In this version of IMPRINT, the task time and accuracy data can not be adjusted to account for personnel characteristics, stressors, or training. If you want IMPRINT to automatically adjust the task performance data for these variables, you should choose the basic VACP workload method.	IMPRINT information message.	You can not apply the PTS moderators to an Advanced Mission. This message is just reminding you of that fact. If you want to apply the PTS moderators, return to the Mission Information dialog and change the workload radio button to VACP.
You have no analyses to open	IMPRINT information message	You have attempted to open an analyses, but you do not have any existing analyses stored. Click on the OK button, then use New to begin

		working on a new analysis.
You must choose Advanced workload from the Mission Information screen to access this tab	IMPRINT error message	Some of the data items attached to tasks are only available if you are working on an Advanced Workload mission. Click on OK. Then, either pick another tab, or return to the Mission Information dialog and set the workload radio button to Advanced.
You must choose VACP Workload Analysis from the Define Mission/Mission Information screen.	IMPRINT error message	You have selected an option that is only appropriate for a VACP mission, but you have opened a mission that is identified as an Advanced Workload mission. Click on OK, then return to the Define Mission, Mission Information dialog and change the setting of the workload radio button.
You must choose VACP workload from the Mission Information screen to access this tab.	IMPRINT error message	You have attempted to access the Workload tab on the task information screen. You can only do this if you have opened a VACP mission. You must return to the Mission Information dialog and change the workload radio button to access this tab. Click OK to continue.
You must first choose a mission from Define Mission	IMPRINT information message	You attempted to perform an operation that applies to an IMPRINT operational mission, but you have not opened a mission yet. Click on the OK button, then go to Define Mission and open a mission.

Chapter 7 - Glossary

Analysis Description	This is a brief description of the analysis. The Analysis Description is optional.
Analysis Name	The Analysis Name can be 20 characters long and can include spaces and symbols. This information must be entered.
Analysis Version	The Analysis Version can be 20 characters long and can include spaces and symbols. This information must be entered.
Crew Ratio	Crew Ratio is the average number of crews available for each new system in the unit. In some cases where systems are required to operate continuously there may be multiple crews for each system.
Function Criterion	The Function Criterion is a percentage that determines how often the function must meet its Function Time Standard to be considered a success. Enter a value between 0 and 100, inclusive.
Function Name	The Function Name is a brief text label that you will use to uniquely identify each function in your system's mission. The function name is limited to 33 characters. All printable text characters are allowed, including spaces.
Function Time Standard	The Time Standard is the slowest performance time that can be tolerated and have the function to still be considered a success. When IMPRINT executes your mission model, the performance time that is predicted by the aggregation of all tasks in this function will be compared to this standard to ensure that your design can meet the function level time standard. The format for this entry (as with all other time values) is hh:mm:ss.00. So to enter a time standard of 30 minutes, 15 seconds enter 00:30:15.00. Notice that you can enter hundredths of a second after the decimal point.
Maximum Number of Systems	This value is the maximum number of systems that would be assigned to your segment if available.
Mean Time Expression	The Mean Time represents the average number of seconds required to execute a task. You can either enter a mean time value (00:00:30) or you can enter an expression(if clock<=30 then 10 else 15). Each expression is delimited by semicolons. In building the expressions, you can use any of the algebraic or logical operators, including the following: (&, |, >, <, :=,==, +, -,*, and /) and you can use if-then-else statements. The assignment operator is :=. The equivalence operator is ==.
Minimum Number of Systems	This value is the minimum number of systems that must be ready to begin the segment prior to the cancellation time in order to prevent all departure groups from being canceled.

Mission Accuracy Criterion	The Mission Accuracy Criterion is a percentage that determines how often the mission must complete without abort to be considered a success. Aborts are caused when a task fails and the consequence of failure is mission abort. Values can range from 0 to 100.
Mission Criterion	The Mission Criterion is the percentage that represents how often the mission must meet both its time and accuracy standards at the same time. Values can range from 0 to 100.
Mission Description	Clicking this button displays a list of the crew members for the mission selected. The Mission Description is a fairly long text field that you can use to describe the mission you intend to model. The description is limited to 255 characters. All printable text characters are allowed.
Mission Name	The Mission Name is a brief text label that you will use to uniquely identify your system's mission. The mission name is limited to 60 characters. All printable text characters are allowed, including spaces.
Mission Time Criterion	The Mission Time Criterion is a percentage that determines how often the mission must meet its Mission Time Standard to be considered a success. Values can range from 0 to 100.
Mission Time Standard	The Time Standard is the slowest performance time that can be tolerated and have the mission still be considered a success. When IMPRINT executes your mission model, the performance time that is predicted by aggregating your individual tasks will be compared to this standard to ensure that your design can meet the mission level time standard. The format for this entry (as with all other time values) is hh:mm:ss.00. So, to enter a time standard of 30 minutes, 15 seconds enter 00:30:15.00. Notice that you can enter hundredths of a second after the decimal point.
MMH/System	Annual MMHs/system (ORG, DS, & GS levels) are the total number of annual maintenance manhours (by maintenance level) required to maintain one new system in that unit.
New Systems	This is the number of new systems that will be fielded in the unit.
Number of Days to Simulate	This is the number of days of operations that the IMPRINT maintenance model will simulate. If you define mission segments for more days than are entered here, the model will not execute any segments that go beyond this value. This value defaults to 10.
Number of Ongoing Tasks	This button lets you include the number of ongoing tasks in your expression to calculate overall workload. This value is shown as an "N" in your equation.
Number of Runs	If you would like to run a model more than one consecutive time, you can enter that number in this field. If you have a relatively short scenario (in days), you may want to run the model several times in order to be confident that the data you get from all of the runs is representative. One

	short run may, by chance, produce data that are not very typical. Running a model for a long period of time (e.g., 90 days) will also improve the probability that the results are typical. IMPRINT will automatically begin each run with a new random number seed. This value defaults to 1.
Number Per Departure Group	This value controls the number of systems per group (sometimes referred to as a “frag”) that are sent out on this segment.
OP Tempo	Annual OP Tempo is the usage per year that the new system is expected to accrue in the type and size unit listed.
Overall Workload Expression	This text box contains the overall workload expression as entered by the user from the interfaces above.
Parentheses Buttons	These buttons are used to select parentheses to group parts of the overall workload expression. Select a parenthesis by clicking on the left or right button. The use of parentheses is optional.
Primary Operator	The Primary Operator is the MOS and crew position that will be assigned to perform the task.
Repeating Segments	A Repeating Segment is one in which IMPRINT’s maintenance model will attempt to send more systems out to perform this segment every so often. You can identify the frequency of the segment (e.g., "repeats every four hours").
Replacement Systems	This is the number of old systems that will be replaced in that unit.
Resource/Interface Channels	Resource/Interface Channels are formed by pairing the human resources with the interfaces (e.g., visual/heads up display, motor/control stick). All workload in an Advanced Mission is assigned to a task by setting individual single task demand values for each resource/interface channel used to perform that task.
Scenario Description	The scenario description is a free text field that you can use to document your analysis. It is limited to 255 characters.
Scenario Name	This is the name of your maintenance scenario. You can have many maintenance scenarios for each system.
Secondary Operators	In VACP Missions, you can select one or more secondary operators for each task. The only role a secondary operator plays is that they will be considered during the task reallocation process (under the Adjust menu), if workload overload occurs during your mission execution.
Segment Cancellation Time In Hours	This is the number of hours that the simulation will wait for the minimum number of systems to be available before canceling the segment. For example, if the minimum number of systems for this segment is six and there are only four available at the scheduled start of the segment then

	the segment must wait. If there is a value of “01:00:00.00” in this field, then if the minimum number of systems do not become available within one hour of the scheduled start, the segment will be canceled. The default value for this item is 00:00:00.00. This means that the minimum number of systems must be available at the start time of this segment in order for the segment to begin. Be very careful that your cancellation is not after the segment would be attempting to repeat.
Segment Duration Time in Hours	This value indicates the number of operational hours for this segment. This value is used to schedule the return of the systems from operations and the beginning of the maintenance window. Additionally, this time is used to determine usage for the equipment on which failures are triggered by time.
Segment Priority	When more than one segment has been defined to occur at the same time, the segments must compete for available systems. In this box, you can enter a priority number for each segment. The segment with the higher priority value will get available systems first.
Segment Repeat Time in Hours	If you have indicated that the segment will repeat, you will be able to enter data in this box. The value in this box controls the frequency with which the simulation will attempt to repeat this segment. If you will enter the number 4 in this box, it will indicate that you want this segment to repeat every four hours. In other words, this segment will try to start again every four hours throughout the simulation. If you wanted this segment to repeat only twice, you could do this by defining two separate but identical segments with one starting four hours after the first.
Segment Start Day	This box and the one labeled Segment Start Time work together to identify the start time of this segment. This value defaults to 1. If you were to leave the default values in both of these boxes, this mission would begin at time 0 on day 1.
Segment Start Time	This box contains an indication of when you want this segment to begin. This value defaults to 00:00:00.00.
Shift Data	Enter the maintenance shift length in clock hours and the number of shifts per day. The product of the two numbers must be less than or equal to 24. The number of shifts will determine the number of columns in the manning spreadsheet
Subsystem Equipment Type	The subsystem type indicates the operational units that are used to describe the usage for that subsystem. Usage for an armament subsystem is described as the number of rounds that have been fired from that subsystem. Usage for components in a distance subsystem is described in terms of the number of miles that the system has traveled. Subsystems with a type of “Other” use operational time as the usage measure.
Subsystem Name	This column of the spreadsheet contains the name of the subsystem.

	Names must be unique.
Subsystem Type	The subsystem type indicates the operational units that are used to accrue the usage for that subsystem. Usage for an armament subsystem is described as the number of rounds that have been fired from that subsystem. Usage for components in a mobility system is described in terms of the distance that the system has traveled. Subsystems with a type of “Other” use operational time as the usage measure.
Task Accuracy Description	The task accuracy description is a combination of a numerical value and a measure which, taken together, indicate the accuracy performance standard for a task.
Task Accuracy Mean and Standard Deviation	This option allows you to specify an average value for how accurately a particular task is likely to be performed. For example, you might say that on the average when performing this task the operators get 90 percent of the steps correct or for another tasks, they are within 10 mils of the correct azimuth. Under the first option, you will also specify the standard deviation, which in some sense is a measure of the worst and best the task is likely to be performed. An easy rule of thumb for specifying the standard deviation is to compute the difference between the worst and best performance and divide it by 6. For example, if the worst performance is 40% steps correct and the best is 100%, then an estimate for the standard deviation would be 10% (((100 - 40)/6) = 10). Under this option you will define what is acceptable performance by specifying an accuracy standard. For example, you may say that any error greater 5 mils causes firing inaccuracies that are unacceptable. With the information above, the model then computes the probability of the task performance being at or above the standard and compares a selected random number to determine if task was performed accurately.
Task Accuracy Probability	This option "Probability of Success" skips the requirement for specifying all the detailed data (i.e., mean, standard deviation, and accuracy standard) in the option above and goes straight to specifying a probability of success, which again is compared with a random number to determine if the task was performed accurately.
Task Criterion	The task criterion indicates the percentage of time that the task must meet its time and accuracy standards in the same simulated occurrence.
Task Mean Time	The task mean time value is used in conjunction with the task standard deviation and the distribution type to generate a predicted performance time for this task. When IMPRINT runs, a random number is generated and is used to pull a number from the distribution you have specified. This number becomes the task time for that occurrence of the task.
Task Name	This text box displays the name of the task for which you are displaying or entering information. To move from one task to another use the "Previous" button.

Task Priority	Task priorities are used to execute priority-based workload management strategies. The priorities range from 1 (very low) to 5 (very high). New tasks are assigned a priority level of 3 (medium). To change a priority level for a task, double click on a task to open the task parameter window, click in the Task priority field of the task and enter a priority value between 1 and 5, or click on the drop box in the task priority field and select a priority from the list.
Task Standard Deviation	The task standard deviation value is used in conjunction with the task mean time and the distribution type to generate a predicted performance time for this task. When IMPRINT runs, a random number is generated and is used to pull a number from the distribution you have specified. This number becomes the task time for that occurrence of the task.
Task Time Distribution	The task time distribution is used in conjunction with the task standard deviation and the task mean time to generate a predicted performance time for this task. When IMPRINT runs, a random number is generated and is used to pull a number from the distribution you have specified. This number becomes the task time for that occurrence of the task. IMPRINT contains normal, log normal and gamma statistical distributions.
Task Time Standard	The Time Standard is the slowest performance time that can be tolerated and have the task still be considered a success. When IMPRINT executes your mission model, the Estimated Task Mean Time, Standard Deviation, and Distribution are used to choose a specific task time for each occurrence of each task. These times are then accumulated throughout the model run and compared to the time standard in order to report the percentage of successes for each task. To enter the time standard, use the mouse to position the cursor in the time standard box. The format for this entry (as with all other time values) is hh:mm:ss.00. So to enter a time standard of 30 minutes, 15 seconds enter 00:30:15.00. Notice that you can enter hundredths of a second after the decimal point.
Time Between Departures in Minutes	This value is the time between when each group departs to perform their segments.
Time Format	To enter any time data, use the mouse to position the cursor in the time standard box. The format for all time values is hh:mm:ss.00. So to enter a time standard of 30 minutes, 15 seconds enter 00:30:15.00. Notice that you can enter hundredths of a second after the decimal point.
Unit Description	This option lets you identify the unit that you are modeling and the number of systems in that unit. This information is used in IMPRINT to determine the Force-level manpower and personnel requirements of your system.
Unit Sizes	This drop down list is used to choose the size of the unit being listed on the Force Structure dialog. The unit sizes are: Corps, Division, Brigade/Regiment, Battalion, Company/Battery/Troop, Platoon, Section,

	and Other.

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Index

Appendix A - Technical Description of Stressor Implementation

Evaluation of Human Performance under Diverse Conditions

via Modeling Technology

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Streamlined system acquisition and resource constraints are realities of military test and evaluation today. However, the pressure of saving time and dollars cannot be permitted to eliminate the assessment of total system performance - that is, the soldier, the hardware, and the software. Assessing combined soldier-system performance is as critical as ever. To address the challenges of the future battlefield requirements documents being written for military systems today regularly require operation in cold and hot conditions; in nuclear, biological, and chemical (NBC) environments; and over extended time periods. More and more functions are required to be automated, which does not necessarily make the job easier but, more likely, changes the nature of the job, the crew size, the task allocation, and the skills and abilities needed to do the job. These kinds of system requirements generate soldier-system dynamics that will affect overall system performance and must be evaluated throughout the system acquisition, design, and ultimately, the test and evaluation process.

In addition to the time and cost-effectiveness considerations that are givens for test and evaluation, regulations governing human use and test participant safety must also be considered. It is simply not permitted to test systems under all of the actual conditions in which they are required to operate. Certain hazardous conditions, for example, NBC operations, must be approximated. It is being proposed here that modeling not only provides a reasonable alternative for the approximation of performance under diverse--even extreme--conditions, but it also can be accomplished within the time and cost constraints. Existing data can be used to extrapolate to other conditions. Once a baseline model is built, excursions are typically straightforward. Modeling can be used iteratively to evaluate different conditions or to conduct sensitivity analyses and comparisons.

Over and above the ways in which modeling technology helps to address the time, cost, and safety concerns of test and evaluation, it offers a logical and sound approach to estimating human performance. It is a task-analytic approach that lends itself to good documentation and the building of audit trails. It can be used to help quantify what are, all too often, largely subjective assessments. It can also compensate for, or be used to extend operational field data that come with certain innate limits such as uncontrollable extraneous variables, small sample size, and non-repeatability. Modeling too, has its limitations; however, in combination with more traditional test and evaluation methods, for example, in a model-test-model mode, it can provide valuable estimates of human performance under a wide variety of conditions.

The IMPRINT Tool. The U.S. Army Research Laboratory Human Research and Engineering Directorate has developed a modeling and analysis tool, the Improved Performance Research Integration Tool (IMPRINT). The IMPRINT tool grew out of common U.S. Air Force, Navy, and Army manpower, personnel, and training (MPT) concerns identified in the mid-1970's: How to estimate MPT constraints and requirements early in system acquisition and how to enter those considerations into the design and decision-making process. The U.S. Navy first developed the HARDMAN (Hardware vs. Manpower) Comparability Methodology (HCM). The Army then tailored the manual HCM, which became known as HARDMAN I, for application to a broad range of weapon systems and later developed an automated version, HARDMAN II. In HARDMAN I and II, however, there was no direct link between MPT and performance. To directly remedy this shortcoming, the U.S. Army began the development of a set of software analysis modules in the mid-80's (Kaplan, 1988). This set of modules was called HARDMAN III, and although the name was the same, it used a fundamentally different approach for addressing MPT concerns than previous methods. It provided an explicit link between MPT variables and soldier-system performance. IMPRINT, while being an improvement over HARDMAN III, for the purpose of the discussion here, is essentially HARDMAN III in the Windows™ environment.

The mechanism for the MPT-performance link is task network modeling provided by the commercially- available Micro Saint task network simulation modeling engine, PC software designed for describing and analyzing task networks. The modeling capability offered can be further characterized based on three distinctions (Law & Kelton, 1991): (1) static vs. dynamic, (2) deterministic vs. stochastic, and (3) continuous vs. discrete. A static model does not address system effects over time, whereas a dynamic model represents a system as it changes with time. A deterministic model does not represent any probabilistic, or random, elements. A stochastic model does encompass random elements and produces output that contains random error. A discrete model refers to instances where the variables characterizing the system change instantaneously at separated points in time. A continuous model is the converse, with variables that change continuously with time. In some instances, systems can be treated as either discrete or continuous, depending on the objectives of the analysis.

Using these definitions then, IMPRINT can be described as a dynamic, stochastic, discrete event modeling tool. When certain assumptions hold, namely, that the system of interest can be adequately described by task activities and networked sequencing, that dynamic processes and random variability are of interest, and that any continuous tasks can be fairly transformed into discrete tasks, then IMPRINT is an appropriate tool to use to represent and analyze soldier-system performance.

The basic modeling capability in IMPRINT requires the decomposition of a system mission into functions which, in turn, are decomposed into tasks. The functions are linked together into a network describing the flow of events. The network can include various types of branching logic such as parallel branches, probabilistic branches, and repeating branches. Within each function, the tasks are sequenced using the same types of branching logic options. At the task level, estimates of task performance time and accuracy means and standard deviations are input along with the consequences of the failure to perform a task accurately enough. The failure consequence options are no effect, total mission abort, repetition of that or some other task, or subsequent degradation of some other task. The data entered are assumed to be representative of performance under "typical" or baseline conditions. Also, standards of performance can be entered to provide benchmarks for performance adequacy at the mission, function, and task levels. A sample IMPRINT screen depicting both the function and task level networks is shown in Figure 1.

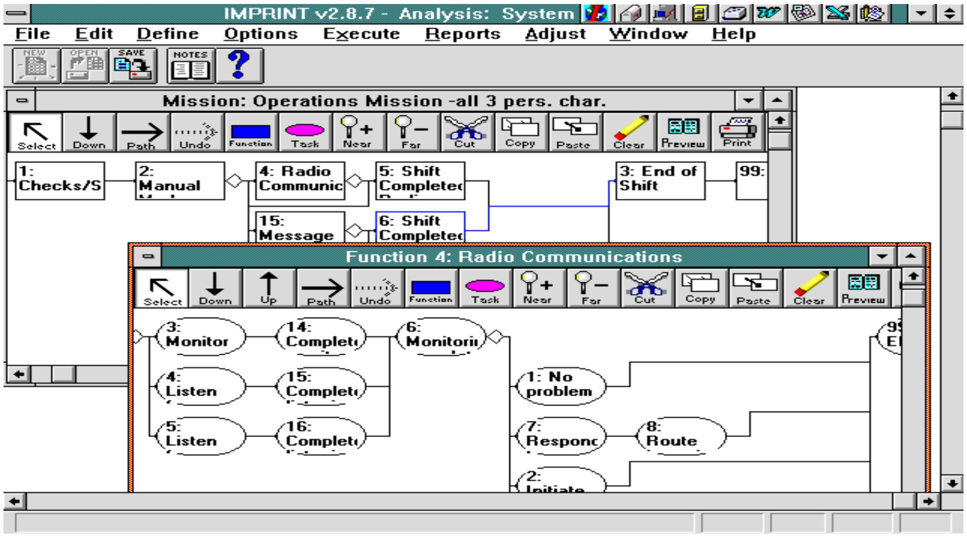

Figure 1. Sample IMPRINT Function and Task Network Windows.

IMPRINT executes a mission model task-by-task by first drawing a task time from the distribution as defined by the mean and standard deviation input for each task. (IMPRINT assumes a default normal distribution although other distribution options are available). Then it calculates the probability of success for the task based on the accuracy inputs. Next it determines, for this instance, whether there is an accuracy failure. After checking for a given task, IMPRINT proceeds through the task and function networks in accord with the established branching logic and analyzes the output according to the standards. When the model execution is completed (which can be anywhere from 1 to 999 repetitions), reports of estimated performance at each of the three levels are generated along with the comparisons to the standards. Although any given model and its associated assumptions must be scrutinized, this approach is particularly useful for comparisons across systems or system conditions.

<u>The Environmental Stressors in IMPRINT</u>. Along with the basic task network simulation modeling capability, the IMPRINT tool includes specific algorithms or look-up tables--environmental stressors--to assess performance under diverse conditions. Recall that the task performance data entered in the baseline model are assumed to represent performance under “typical” conditions. The embedded environmental stressors automatically adjust performance to account for the changes expected under different levels of the stressors. Currently, IMPRINT includes five environmental stressors: protective clothing (i.e., Mission-Oriented Protective Posture or MOPP), heat, cold, noise, and hours since last sleep (see Figure 2). The application of a stressor will result in either less accurate task performance, longer times to complete the task, or both.   Stressors may be applied to an individual task or to all the tasks assigned to a particular job or Military Occupational Specialty (MOS) for the mission. When the model is re-run, the new, or “stressed,” task performance time and/or accuracy are used as the task estimates that are “rolled up” in the task, function, and mission reports and compared against the standards. Importantly, the results can also be compared with the baseline model predictions. (See Dynamics Research Corporation, & Micro Analysis & Design, 1993) for more complete documentation.)

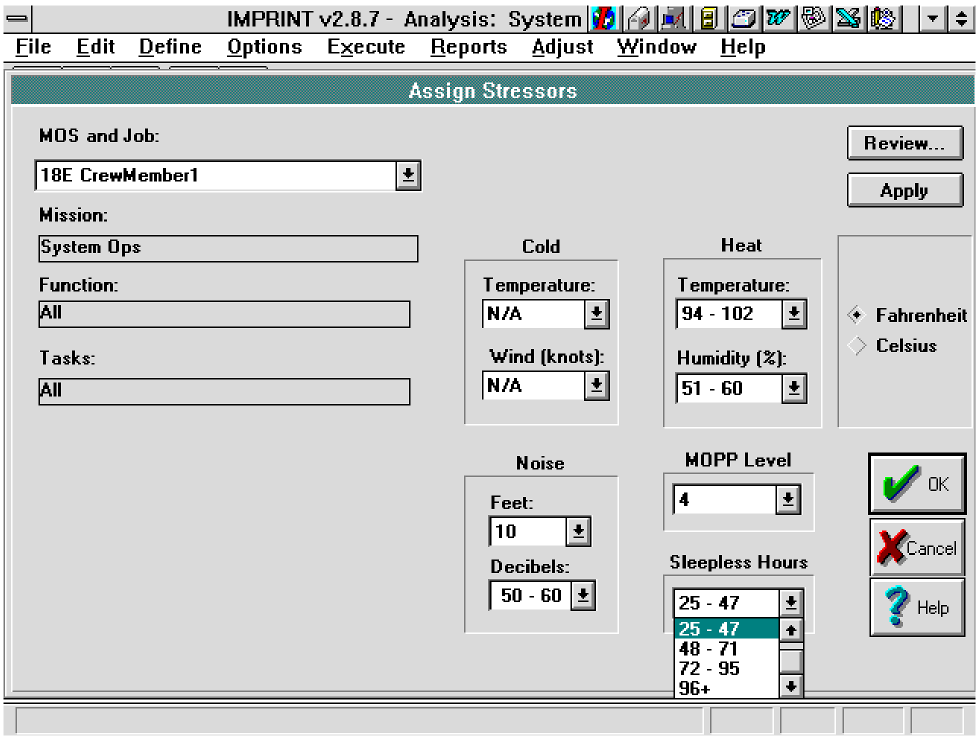

Figure 2. IMPRINT Window Showing the Environmental Stressor Options.

As a side note, IMPRINT also models the effects of two task performance shaping functions, based upon personnel characteristics and training frequency and recency. The personnel characteristics function uses both standardized MOS entrance scores and the general Armed Forces Qualification Test (AFQT) scores. Different from the stressors, which only degrade performance, applying the performance shaping functions can result in either better or worse performance, depending on the level selected. For example, increasing the frequency of training results in improved performance, whereas decreasing the frequency lowers performance. IMPRINT also models the mental workload associated with task performance. Workload profiles can be developed for crew members, or, in the advanced mode, the interaction of workload and performance can be evaluated to include workload coping strategies and task-workload conflicts. Although these functions provide important analytic capabilities, the focus of the paper from this point is solely on the environmental stressors.

Before discussing each stressor in turn, it is important to note that not all tasks are affected in the same way or by the same stressor. To accommodate this, IMPRINT uses a task category weighting scheme. Nine categories or taxons used to describe a task (see Table 1) (Fleishman & Quaintance, 1984). Category weights are assigned to each task so that the various stressor effects are likewise weighted. In this way, each task contributes only the appropriate amount of change to the "stressed" performance at the mission level. Every task can be categorized with as many as three taxons. For example, operating a tractor and semi-trailer may involve driving a vehicle that is classified as "fine motor continuous" and may involve giving or receiving instructions, which is classified as "communication (oral)." Additionally, weights, which must sum to 1.0, are used to describe the degree to which a particular task manifests a particular taxon. In the example cited, operating a tractor and semi-trailer task might be composed of .75 fine motor continuous and .25 communication (oral). Modification of the taxon weights also allows for the consideration of new technology. For example, an automatic reloading device could change a heavy lifting or gross motor heavy task to a fine motor discrete task where only the manipulation of controls is required.

Table 1. The Nine IMPRINT Taxons, Their Descriptions, and Task Examples

Taxons	Definitions	Examples
Visual	Requires using the eyes to identify or separate targets or objects	• Seeing something move and then recognizing it as an enemy tank
Numerical	Requires performing arithmetical or mathematical calculations	• Measuring an azimuth on a map with a protractor • Estimating the distance between two points on a map
Cognitive (Problem Solving and Decision Making)	Requires processing information mentally and reaching a conclusion	• Locating a fault in an electrical system after troubleshooting • Selecting the best firing position for a machine gun
Fine Motor Discrete	Requires performing a set of distinct actions in a predetermined sequence mainly involving movement of the hands, arms, or feet with little physical effort	• Assembly and disassembly of the M-16 rifle • Starting the engine of a truck
Fine Motor Continuous	Requires uninterrupted performance of an action needed to keep a system on a desired path or in a specific location	• Driving a vehicle • Tracking a moving target
Gross Motor Heavy	Requires expending extensive physical effort or exertion to perform an action	• Lifting an artillery round • Loosening a very tight bolt with a wrench
Gross Motor Light	Requires moving the entire body (i.e., not just the hands) to perform an action without expending extensive physical effort	• Getting into a prone firing position • Evacuating a tank
Communication (Read and Write)	Requires either reading text or numbers that are written somewhere or writing text or numbers that can be read	• Reading a preventive maintenance check list for a vehicle • Writing a letter home
Communication (Oral)	Requires either talking or listening to another person	• Giving a situation report by radio • Receiving a password from someone while on guard duty

Table 2 details which task taxons are affected by which stressors in the current IMPRINT software. It also shows whether the task performance is degraded by time, accuracy, or both. Since degradation factors are processed as multipliers, the degradation factors affecting time will be greater than 1.0 to increase the performance time. On the other hand, the degradation factors affecting accuracy will be less than 1.0 to decrease the performance accuracy from the pre-existing accuracy level. The overall degradation resulting from a specified stressor is directly proportional to the weighting assigned to the affected taxon(s) comprising the task.

Table 2. Listing of the IMPRINT Environmental Stressors and the Taxon Types Affected by Either Time or Accuracy or Both.

Taxon	MOPP	Heat	Cold	Noise	Sleepless Hours
Visual	T	A	T		
Numerical		A			TA
Cognitive		A			TA
Fine Motor Discrete	T	A	T		
Fine Motor Continuous					
Gross Motor Light	T		T		
Gross Motor Heavy					
Commo. (Read & Write)		A			
Commo. (Oral)	T	A		A	

where T = Affects task time only

A = Affects task accuracy only

TA= Affects task time and accuracy

MOPP. The effect of MOPP gear on task performance is modeled as a function of levels of MOPP gear and task taxon. As shown in Table 2, MOPP affects the time that it takes to complete tasks described by the visual, fine motor discrete, gross motor light, and communication (oral) taxons. The degradation factors were derived from a series of studies conducted by the former Ballistic Research Laboratory (Wick, 1988) where the measure of performance degradation for each task was the time difference between performing the task in Battle Dress Uniform (BDU) and performing it in MOPP 4. Each task was later described in terms of ten human ability codes. These codes were mapped to the IMPRINT taxons and the degradation factor for each taxon was computed as the average of the mapped degradation factors by human ability code. MOPP level 0 is equivalent to BDU and therefore has a degradation factor of 1 that correlates to “no degradation.” Degradation factors are applied as multipliers against the time that it takes to complete a task in BDUs. The most degraded performance is under MOPP 4 for fine motor discrete tasks and for oral communication tasks that take 1.7 times as long to perform. (The entire set of matrices of degradation factors for the stressors is not provided here but is available from the author on request.)

Heat. IMPRINT models the effects of heat on task performance accuracy as a function of dry bulb temperature and relative humidity using degradation factors based on various published reports and documents. Research relating heat stress to inaccurate performance (e.g., Ramsey & Morrissey, 1978) was referenced. The MIL-HDBK-759-A (1981) was used to determine the effective temperature for different combinations of dry bulb temperature and relative humidity. And, data on the average number of mistakes per man-hour as a function of effective temperature from the Bioastronautics Data Book (1981) were included in the derivation of the heat degradation factors. The derived factors applied solely to sedentary type tasks. Thus, the taxons affected are visual, numerical, cognitive, fine motor discrete, communication (read and write), and communication (oral). No degradation in accuracy performance is seen until the temperature reaches approximately 113^o F (or 45^o C) and the humidity reaches approximately 50%. Performance falls to essentially zero when the temperature reaches approximately 130^o F (or 55^o C) and the humidity reaches approximately 80%.

Cold. Cold weather degradation factors affecting task time performance are modeled in IMPRINT as a function of ambient temperature and wind velocity. Two functional relationships were developed from a study (Teichner, 1958) that related wind chill to percentage of performance loss. One relationship was developed for visual reaction time, thus providing the data for the visual and fine motor discrete taxons; the other was developed for manual skills, providing the data for the gross motor light taxon. The degradation factors for cold are computed as the percent loss of performance as a function of wind chill, wind chill being a function of wind velocity and ambient temperature. Time effects range from a minimum of 1.03 times as long for temperatures of approximately 35^o F (or 1^o C) and a wind velocity of approximately 10 knots to a maximum of 1.70 times as long for temperatures of approximately -40^o F (or -40^o C) and a wind velocity of greater than 50 knots. Note that this degradation does not account for prolonged exposure to cold and wind.

Noise. The way in which IMPRINT models the effect of noise on task performance is based on the effectiveness of voice communications as a function of noise level and distance between the speaker and the listener. As shown in Table 2, the degradation that results from various noise levels affects the accuracy with which a task that requires oral communications between two or more people is performed. The effect of noise on task accuracy and the resultant degradation factors were derived from a graph in MIL-STD-1472C. Distances modeled range from 1 to greater than 20 feet and noise levels range from 50 to greater than 110 dB PSIL. Approximately midway through the ranges modeled, accuracy of performance essentially drops to zero, as might be expected.

Sleepless Hours. In IMPRINT, sleepless hours refers to extended operations or the lack of sleep. It is important to note that sleep deprivation is the only environmental stressor that causes degradation in both the time to perform a task and the accuracy with which it is performed. IMPRINT models the stress of continuous operations as a function of hours since last sleep. Ranges of hours since last sleep go from 24 hours to greater than 96. At the 96-hour range, time to perform tasks is essentially doubled and accuracy has dropped to zero. The factors included in IMPRINT were derived from a review of several studies (Belenky et al., 1987), which found that the only taxons that are affected by lack of sleep are numerical and cognitive. Of note, in contrast to cognitive performance, physical strength and endurance are relatively unaffected by lack of sleep and can be restored by simple rest.

Multiple Taxons with Multiple Stressors. Many combinations of multiple stressors and taxons are also implemented in IMPRINT. Table 3 shows the possible combinations of stressors and the associated taxons. When two or more different stressors affect a task's taxon in time or accuracy, the overall degradation is not just the sum of the individual degradations. In fact, the overall degradation is less than the sum of the individual degradations. As more stressors are added, they have less than the full effect on performance. Normally, the most severe stressor will have a full effect on performance. As additional stressors are added, they will have less and less impact on performance accuracy and time. This phenomenon is approximated with a power function (Harris 1985).

Table 3. Possible Combinations of Stressors and Taxons Implemented in IMPRINT.

Stressors	Taxons
MOPP & Heat	Visual Fine Motor Discrete Communication (oral)

MOPP & Cold	Visual Fine Motor Discrete Gross Motor Light
MOPP & Noise	Communication (oral)
Heat & Noise	Communication (oral)
Heat & Sleepless Hours	Numerical Problem Solving
MOPP & Heat & Cold	Visual Fine Motor Discrete
MOPP & Heat & Noise	Communication (oral)

IMPRINT Verification, Validation, and Accreditation (VV&A). HARDMAN III, the IMPRINT predecessor was subjected to a formal VV&A process, the first of its type in the U.S. Army. The first phase, which is applicable here, comprised the core task network modeling capability and the effects implemented as additions to or modifications of the task data--mental workload estimation and environmental degradation, personnel characteristics, and training. A review board of representative users, policy-makers, technical experts, and soldier proponents evaluated the findings against eight criteria: configuration management, software verification, documentation, data input requirements, model granularity, validity of modeling techniques and embedded algorithms, output, and analysis timelines. All criteria were satisfied and formal accreditation was granted in January 1995 with only limited caveats (see Allender et. al, 1995).

Since the environmental stressors were transitioned to IMPRINT without modification, the basic VV&A transitioned as well. Of note, although this portion of the software was approved and the basic approach of degrading time and/or accuracy of performance on a task-by-task basis was supported, the consensus was that all the algorithms warrant updating and that new algorithms need to be developed to fill the voids. Referring to Table 2 and to the dates of some of the environmental stressor references, it is clear that there are substantial voids and that there is certainly new research that should be accounted for in this arena.

Examples of the Method for Test and Evaluation. One example of the implications of this modeling approach to the test and evaluation arena was reported by Allender, McAnulty, and Bierbaum (1992). They describe the application of the predecessor HARDMAN III software to the analysis of potential options for reducing turnaround time in an Apache Forward Arming and Refueling Point (FARP). Once the baseline was constructed, three options were compared: adding a new equipment component, adding personnel, and changing reloading tactics, that is full vs. half reload of one ammunition type. The level of effort involved in the evaluation of options was only a fraction of the baseline development costs and certainly only a fraction of comparable field trials. Since the modeling effort was conducted at the same time as the test planning was under way, the results were available to the test planners to help focus testing and to serve as a validation reference. They asserted that the results were appropriate to be used in interaction with testing, not as a substitute.

Another example is the work reported by McMahon, Spencer, and Thornton (1995). Within months of a final milestone review, an NBC reconnaissance system called the Fox had been given an “unacceptable” operational assessment at the completion of a large-scale field test. The central issue was that a four-seat vehicle had not been modified to fit the new three-person crew. The operator was forced to switch positions repeatedly in order to do the job, which caused safety problems and unacceptable performance. Coupled with modeling of proposed changes to the equipment and display layout, two mission models were built: the baseline and the proposed re-design. The mission model predicted substantially reduced workload and improved performance. Subsequently, the system was retro-fitted for a limited, two-week test which validated the model predictions. From this example the time, cost, and even safety benefits of using modeling in conjunction with testing are quite evident.

Proposed Environmental Stressor Developments. The examples provided in the previous section are good evidence for the utility of modeling in the test and evaluation arena; however, a comprehensive application of the environmental stressors for test and evaluation has not been completed. This is clearly a priority. Also, the shortcomings, voids, and need for updates to the stressors are obvious.

At this time, the literature in this area is being re-surveyed in order to develop a prioritized list of stressor updates, enhancements, and additions. Criteria for the prioritization are user need and availability of generalized data. Several other organizations have also identified this type of work as critical and plans for leveraging and cooperation are under way. Work of note includes that being performed under the auspices of the United Kingdom Defence Evaluation Research Agency Centre for Human Sciences, the Integrated Performance Modeling Environment. The U.S. Defense Special Weapons Agency (formerly the Defense Nuclear Agency) has published work in this area also (e.g., Anno, Dore, & Roth, 1996). Close at hand, the U.S. Army Research Laboratory Human Research and Engineering Directorate is currently investigating databases on various dimensions of psychological stress as related to performance for inclusion in IMPRINT.

In conclusion, the IMPRINT tool offers a modeling technology for evaluating human performance under diverse conditions. Based on sound task analysis, network modeling, and environmental stressor degradation algorithms tailored to task type, assessments of performance under diverse conditions can be used to augment test and evaluation today. With continued development, the capability to perform these types of analyses will be further enhanced.

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Appendix B - Human Performance MicroModels

Perceptual Models

Basic Parameters

Eye Movement Time (target located in eye field)	100 msec (travel time only)	Houtmans & Sanders, 1984; Sanders & Houtman, 1985
Head Movement Time (target located in head field)	200 msec (travel time only)	Houtmans & Sanders, 1984; Sanders & Houtman, 1985
Eye Fixation Time	100 msec - 500 msec	Houtmans & Sanders, 1984; Sanders & Houtman, 1985
Search Time	(Tm + Tf)N where N = number of fixations, Tm = movement time, Tf = fixation time	
Reading Rate	52 words/min (5 saccades per word), 261 words/min (1 saccade per word), 652 words/min (1 saccade per phrase), Assumes: 5-letter words, 2.5 words or 13 characters per phrase	Card et al., 1983
Listening	Rate: 2.4 words/sec	Miller and Licklider, 1950

Motor

Basic Parameters

Hand Movement (Fitt's Law-Welford Variant)	$I_M \log_2 [D/S + 0.5]$ where T = Movement Time, D = Distance between targets, S = Size of Targets, I_M = Slope Constant = .1 sec/bit	Welford, 1968

Hand Controls

Pushbutton or Toggle	400 msec	Harris et al., 1988
Rotary Dial	730 msec	Harris et al., 1988
Cursor Movement with Trackball	$I_M * \log_2 (d/s + 0.5)$ where I_M = constant = 100 msec/bit, d = cursor distance to be moved, s = display symbol width	Harris et al., 1988, from Fitt's Law
Cursor Movement with Mouse	$1.03 + .06 \log_2 (D/S + .5)$ sec, D = Distance to target, S = Size of target	Card et al., 1983
Cursor Movement with Joystick	$K_D + .100 \log_2 (D/S +.5)$ sec where K_D = intercept distance for distance D, D = Distance moved, S = Size of target	Card et al., 1983
Cursor Movement with Step Keys	$98 + .074 (D_x/S_x + D_y/S_y)$ sec, where D_x=Horizontal distance to target, D_y=Vertical distance to target, S_x=Size of a vertical step (default = .456 cm), S_y=Size of a horizontal step (default = .246 cm).	Card et al., 1983
Cursor Movement using	$.66 + .209 N_{min}$ sec.	Card et al., 1983

Text Keys	where: .209 = Keystroke rate (in sec/keystroke) which approximates the typing rate for random words, N_{min} = minimum number of keystrokes.	
Single Finger Keying Rate	.140 [.060 = .200] sec	Card et al., 1983
Typing Rate	.209 sec/keystroke	Card et al., 1983
Walking Rate	0.19 sec/foot	Harris, 1988

Speech

Basic Parameters

Speech rate	3.4 words/sec (large vocabulary), 2.4 words/sec (small vocabulary)	McCormick, 1970

Cognitive

Basic Parameters

Perceptual Process	τ_P = 100 msec	Card et al., 1983
Decision Process	τ_C = 70 msec	Card et al., 1983
Motor Process	τ_M = 70 msec	Card et al., 1983
Simple Reaction Times - On/Off Response	$\tau_P + \tau_C + \tau_M$ = 240 msec	Card et al., 1983
Simple Reaction Times - Physical Match	$\tau_P + 2\tau_C + \tau_M$ = 310 msec	Card et al., 1983
Simple Reaction Times - Name Match	$\tau_P + 3\tau_C + \tau_M$ = 380 msec	Card et al., 1983
Simple Reaction Times - Class Match	$\tau_P + 4\tau_C + \tau_M$ = 450 msec	Card et al., 1983
Choice Reaction Time	K * $\log_2$ (n+1) where: k is a constant representing simple RT and is set at 150 msec., n is number of	Hick's Law as discussed in Card et al., 1983

	possible alternatives	
Mental Rotation (Visualization)	1 sec + (R / 50° per sec) where: R = amount of rotation from initial perceived view to final visualized view (in degrees)	Shepherd and Metzler, 1971

Special

Prioritization (i.e., of targets)	.310[n(n+1) / 2] where: n = number of targets in a sector. This formula treats prioritization as a unidimensional [worth] pairwise comparison between all possible targets in a sector.	McCarthy and Plocher, 1990
Terrain Association	Two stage process: Stage 1. Reduce size of area of uncertainty: Time = 5 sec. (Performed once every time a completely new view is encountered.), Stage 2. Pinpoint own location Time = 2 sec. Per terrain matching attempt. (Four to seven matching attempts required to pinpoint own location. Other job activities are typically interspersed in between terrain matching attempts.)	Cross, Rugge, and Throndyke, 1982

Appendix C – Micro Saint Functions

The purpose of this appendix is to provide samples of built-in functions that can be embedded in expressions within an Advanced Workload Model or a Goal Oriented Model. These functions are provided through the Micro Saint language, which is used within IMPRINT.

Micro Saint contains a set of built-in functions that control the execution of a model and the icons contained within the ActionView animation. Micro Saint contains a set of built-in functions that control model execution. For many of these functions, you supply the tag value, task number, or group value.

The tag value is an integer that records the identity of each entity when multiple entities travel through a network. Each entity is assigned a default tag value of zero when it is generated, but you can assign a new tag value to an entity at any point. Once an entity has a tag value, the value stays with that entity through the remainder of model execution or until you change it. In IMPRINT you will usually use a tag number of 0.

The task number is the number assigned to the task by Micro Saint. The task number displays on the Network diagram when IMPRINT is running, Refer to the description of MSID for more information.

The group value is identical to the tag value, but is used to control groups of tasks. As with the tag variable, the group value is carried through the simulation.

Model functions include the following:

- Abort

  Syntax: abort(task number, tag value)

  Description: Aborts the task identified by the task number you supply, if it is currently processing the entity identified by the tag value you supply. The Ending Effect of the task being aborted is not executed. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2 or 1a, it is truncated.

- Abort Tags

  Syntax: abortTags(task number)

  Description: Aborts all tagged entities in the task identified by the task number you supply. The Ending Effect of the task being aborted is not executed. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2 or 1a, it is truncated.

- Abort Tasks

  Syntax: abortTasks(tag value)

Description: Aborts all tasks processing entities identified by the tag value you supply.

- Abort With Group

  Syntax: abortWithGroup(task number, group value)

  Description: Aborts the task identified by the task number you supply, if it is currently processing the entity identified by the group value you supply. The ending effect of the task being aborted is not executed. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2 or 1a, it is truncated.

- Abort Groups

  Syntax: abortGroups(task number)

  Description: Aborts all group entities in the task identified by the group value you supply. The ending effect of the task being aborted is not executed. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2 or 1a, it is truncated.

- Abort Task With Groups

  Syntax: abortTaskWithGroups(group value)

  Description: Aborts all tasks processing entities identified by the group value you supply.

- Halt

  Syntax: halt( )

  Description: When this function is encountered during model execution, the execution is terminated.

- Pause

  Syntax: pause( )

  Description: When this function is encountered during model execution, the model temporarily stops executing. The effect is the same as selecting Pause from the Execute menu, except that a beep sounds to alert you that the model is paused. You can resume execution by selecting Go from the Execute menu, or you can select Halt to stop the current execution.

  This function is useful for debugging a model. Place the pause function in the tasks before a known error and then run the model. The model will execute in a single-step fashion immediately before the error occurs.

- Resume

  Syntax: resume(task number, tag value)

  Description: Resumes the task identified by the task number you supply, if it was suspended earlier while processing the entity identified by the tag value. When the task is resumed, Micro Saint subtracts the execution time spent before the task was interrupted from the total expected execution time (duration) and completes the task in the amount of time that remains. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2, it is truncated

- Resume Tags

  Syntax: resumeTags(task number)

  Description: Resumes all previously suspended copies of the task identified by the task number, for all tag values. For each task copy, Micro Saint subtracts the execution time spent before the task was interrupted from the total expected execution time (duration) and completes the task in the amount of time that remains. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2, it is truncated.

- Resume Tasks

  Syntax: resumeTasks(tag value)

  Description: Resumes all tasks that were suspended earlier while processing entities identified by the tag value you supply. For each task, Micro Saint subtracts the execution time spent before the task was interrupted from the total expected execution time (duration) and completes the task in the amount of time that remains.

- Resume With Group

  Syntax: resumeWithGroup(task number, group value)

  Description: Resumes the task identified by the task number you supply, if it was suspended earlier while processing the entity identified by the group value. When the task is resumed, Micro Saint subtracts the execution time spent before the task was interrupted from the total expected execution time (duration) and completes the task in the amount of time that remains. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2 or 1a, it is truncated.

- Resume Tasks With Group

  Syntax: resumeTasksWithGroup(group value)

Description: Resumes all tasks that were suspended earlier while processing entities identified by the group value you supply. For each task, Micro Saint subtracts the execution time spent before the task was interrupted from the total expected execution time (duration) and completes the task in the amount of time that remains.

- Start

  Syntax: start(task number, tag value)

  Description: Starts the task identified by the task number you supply and assigns the tag value to the entity processed by the task. If the task is already executing, Micro Saint starts another copy of it (even if it is already processing an entity identified by the tag value you supply). If you want Micro Saint to use the current tag value, type the word tag as the second value in the parentheses. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2, it is truncated.

- Start With Group

  Syntax: startWithGroup(group value)

  Description: Starts the task identified by the group number you supply and assigns the group value to the entity processed by the task.

- Stop

  Syntax: stop(task number, tag value)

  Description: Stops the task identified by the task number you supply, if it is currently processing the entity identified by the tag value you supply. Micro Saint stops all copies of the task that are processing entities with this tag value. Micro Saint performs the Ending Effect before stopping the task, but it does not evaluate the expressions for routing to following tasks. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2, it is truncated.

- Stop Tags

  Syntax: stopTags(task number)

  Description: Stops all copies of the task identified by the task number you supply, for all tag values. Micro Saint performs the Ending Effect before stopping the task, but it does not evaluate the expressions for routing to following tasks. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2, it is truncated.

- Stop Tasks

  Syntax: stopTasks(tag value)

Description: Stops all tasks processing entities identified by the tag value. Micro Saint performs the Ending Effect before stopping the task, but it does not evaluate the expressions for routing to following tasks.

- Stop With Group

  Syntax: stopWithGroup(task number, group value)

  Description: Stops the task identified by the task number you supply, if it is currently processing the entity identified by the group value you supply. Micro Saint stops all copies of the task that are processing entities with this tag value. Micro Saint performs the ending effect before stopping the task, but it does not evaluate the expressions for routing to following tasks. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2 or 1a, it is truncated.

- Stop Tasks With Group

  Syntax: stopTasksWithGroup(group value)

  Description: Stops all tasks processing entities identified by the group value. Micro Saint performs the ending effect before stopping the task, but it does not evaluate the expressions for routing to following tasks.

- Suspend

  Syntax: suspend(number, tag value)

  Description: Suspends the task identified by the task number you supply, if it is currently processing the entity identified by the tag value you supply. The task is put into the event queue, where it waits to be resumed by the resume() function. If the task is never resumed, an error message displays at the end of the model run. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2, it is truncated.

- Suspend Tags

  Syntax: suspendTags(task number)

  Description: Suspends all tagged entities in the task identified by the task number you supply. The task or task copies are put into the event queue, where they wait to be resumed by the resume() function. If the tasks are never resumed, an error message displays at the end of the model run. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2, it is truncated.

- Suspend Tasks

  Syntax: suspendTasks(tag value)

Description: Suspends all tasks processing entities identified by the tag value you supply. The tasks are put into the event queue, where they wait to be resumed by the resume() function. If the tasks are never resumed, an error message displays at the end of the model run.

- Suspend With Group

Syntax: suspendWithGroup(task number, group value)

Description: Suspends the task identified by the task number you supply, if it is currently processing the entity identified by the group value you supply. The task is put into the event queue, where it waits to be resumed by the resume() function. If the task is never resumed, an error message appears at the end of the model run. The task number you supply must be an integer, and cannot contain letters. If you supply a non-integer task number, such as 12.2 or 1a, it is truncated.